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THE WATER RESOURCES OF GREENE COUNTY, OHIO

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GEOLOGY AND WATER-BEARING PROPERTIES OF THE GLACIAL DEPOSITS

Pleistocene Glaciation

Most of the thick covering of clay, gravel, sand, and stones that makes up the present surface of Greene County was left by the continental ice sheets of Pleistocene age. Four times in the last million years deep snows accumulated over vast areas in Canada and northern United States and gradually became compacted into glacial ice. At least two of these ice sheets or glaciers spread southward as far as southern Ohio. All the drift exposed at the surface in Greene County was deposited by the latest ice sheet, that of the Wisconsin stage. The Wisconsin ice advanced to within a few miles of Cincinnati and covered Greene County for several thousand years. It melted off this area about 30,000 years ago.

The glacial stage that preceded the Wisconsin is called the Illinoian stage. The Illinoian ice advanced farther south than any of the other glaciers and reached a point slightly south of Cincinnati. Illinoian drift is not exposed in Greene County but it probably underlies the more recent Wisconsin deposits in some areas, and it has undoubtedly been penetrated by some wells. This is suggested by reports from well drillers of yellow clay layers encountered in wells at considerable depths below the surface and interbedded in the blue tills that characterize the ground moraine. The yellow color probably resulted from the weathering of the deposits when they were at the surface of the ground. This situation possibly could have occurred during any of several intervals of ice advance or retreat during a given glacial stage, but extensive weathering of the now buried deposits would have required considerable time, such as the interglacial stage between Illinoian and Wisconsin glaciation. The Illinoian ice is believed to have melted off the Greene County area about 200,000 years ago, a long time before the arrival of the Wisconsin ice. Yellow clay layers were reported at depth in wells 224-L, 579-L, and 709-L*, and in test wells drilled at the Ohio Soldiers and Sailors Orphans Home in Xenia, and they probably have been found but not reported in other wells in the county. Yellow layers have also been detected in wells drilled in other counties of southwestern Ohio (5).

The Illinoian glaciation was not the oldest in Ohio, for it is evident from drainage changes (3) that at least one earlier ice sheet approached but probably did not actually reach the Greene County area. This pre-Illinoian glacier is thought to have been that of the Kansan stage, which occurred about 600,000 years ago.

Former Drainage Systems

Before the great ice sheets of Pleistocene time covered Greene County and blocked or diverted its rivers and filled the valleys with glacial drift, the drainage was much different from that in existence today. The preglacial streams, which were larger than those now draining the county, flowed in broad, deep valleys, whose presence today is indicated in many places by broad, winding depressions in the present topography. Most of the present streams in Greene County as,

* Letter "L" following number indicates that log of well is shown on plate 22.

shown on plate 4, follow the courses of the preglacial valleys and are cutting their channels into the glacial drift that now fills these valleys. Present streams are also cutting into the bedrock in a few places where their courses do not coincide with those of the buried valleys. The glacial drift in the main preglacial valleys in Greene County is, in most places, more than 200 feet thick, and the present streams are 100 to 150 feet below the levels of the uplands. At only a few places, notably in the area northwest of Spring Valley, has the accumulation of drift been of sufficient thickness to obscure completely portions of the old valleys.

From data obtained from outcrops and wells, contours have been drawn on the bedrock surface (pl. 1), which show in detail the ancient drainage channels that now are partly or wholly filled with glacial drift. From the shapes and patterns of the old valleys, as defined by the contours, from the positions of their tributary valleys, and from regional studies made chiefly by Wilber Stout (3), the probable courses of the streams that cut these valleys before or during the different stages of glaciation may be postulated.

The drainage system that existed in Ohio prior to Pleistocene glaciation is called the Teays. The master stream of this system, called the Teays River, rose in the Piedmont area of the southeastern United States and flowed across Ohio in a northwesterly direction in a course that lay a few miles north of Greene County. Because of a drainage divide in its eastern and northern parts, Greene County was not drained by the main Teays River, but was the headwaters area of a large tributary of the Teays that flowed southwestward from Greene County through Montgomery, Butler, and Hamilton Counties. This tributary river, which has been named by Stout (3) the Hamilton River, flowed into the main Teays River somewhere in Indiana. It was formerly thought that the preglacial course of the Hamilton River did not extend into Greene County because of a drainage divide in the western part, but present data, together with studies made in Montgomery County (5), indicate that this river was at one time the principal stream in Greene County. The probable course of the Hamilton River and its tributaries in Greene County is shown on plate 4. The outlines of the valleys are based on the 650-foot contour line as shown on plate 1. The Hamilton River, having cut back into the county from the west through Beaver Creek Township, divided in the Alpha-Trebein area into three main branches. The north branch of the old river cut the broad valley through what is now the Wright-Patterson Air Force Base area and was terminated somewhere in southern Clark County. The middle branch of the Hamilton River cut back into the upland in the direction of Yellow Springs and Clifton, and the southern branch cut a broad valley headward to the Spring Valley and Roxanna areas, and from there it cut back into the upland to the east in the direction of Jamestown. The present Little Miami River, as shown on plate 4, follows a course through Greene County that was originally cut by the middle and southern branches of the Hamilton River. Also in Teays time a short tributary valley was cut back from the north into the northeast corner of Greene County. Apparently this was a tributary of the main Teays River, whose course lay to the north.

In Greene County in Teays or preglacial time a narrow col or drainage divide existed at the site of Huffman Dam in Bath Township, separating two short tributaries of the Hamilton River. Another col existed about a mile southeast of Osborn,

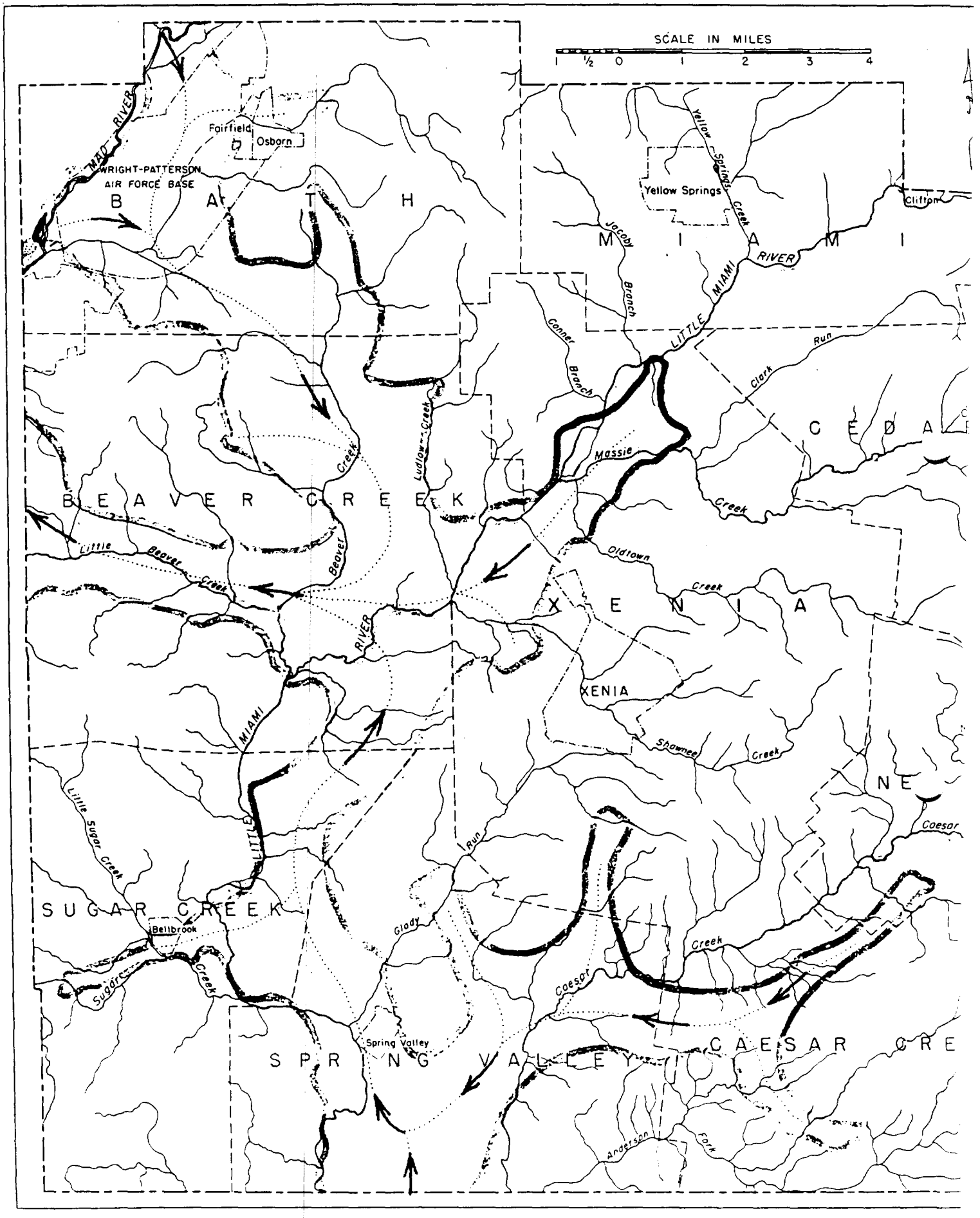


Plate 4. Map of Greene County, Ohio, showing the present drainage syst

and there were smaller cols at other points within the county. The level to which Teays stage drainage cut its valleys in Greene County is conjectural because of the effects of later drainage stages and because the old valley floors are obscured by glacial drift. According to studies made in adjacent Montgomery County (5), the Teays level in the northern part of that county is found at elevations ranging from 750 to 770 feet, as indicated by rock terraces that occur along some of the valleys. Though such terraces are not discernible in Greene County, the Teays level must have been at somewhat similar elevations except near the headwaters areas of the valleys.

The Teays drainage system, according to Stout (3), was terminated by the advance into central Ohio of a very early, pre-Illinoian glacier, perhaps that of the Kansan glacial stage. This early glacier, it is thought, never reached the Greene County area, but it did advance far enough to block the main Teays River to the north. This caused lakes to form in the main valleys into which, in some areas, silt and clay were deposited. The lake stage was ended when the water overflowed and cut through narrow drainage divides, or cols, and established the succeeding drainage system, which is called the "Deep Stage" system. The Deep Stage drainage system was interglacial, because it followed the advance of the pre-Illinoian glacier and was terminated by the later advance of the Illinoian ice sheet. It is called Deep Stage because during this time the streams cut deep, narrow valleys many feet below the levels established in Teays time.

It seems probable that Deep Stage drainage in Greene County followed the courses established in Teays time, inasmuch as the southwestward-flowing Hamilton River probably was not ponded by the pre-Illinoian glacier. During Deep Stage time the bedrock floors of the valleys were reduced to their present levels, more than 200 feet below the levels established in Teays time. The Illinoian glacier, which brought the Deep Stage system to a close, covered the area with drift. Post-Illinoian drainage was probably somewhat similar to the present system, which has evolved since the more recent Wisconsin glaciation. As shown on plate 4, the present drainage has been diverted through narrow cols at Huffman Dam, in the Bellbrook area, and in the area south of Alpha. These cols probably were breached when the Wisconsin ice front stood at or near these localities and forced the drainage over the divides.

Wisconsin Glacial Deposits

By Richard P. Goldthwait

The Wisconsin ice sheet, the last great glacier of Pleistocene time, advanced and retreated a number of times over southwestern Ohio, and two distinct drift sheets of Wisconsin age are present in Greene County. These drift sheets are differentiated according to the degree of weathering of their soils and correspond to early and late Wisconsin time. Drift from the early Wisconsin ice is found at the surface only in the area south of Bellbrook in the southwestern corner of the county. There the drift has been weathered to a deep, yellow-brown soil that has been

leached of its carbonates to depths of 4 to 6 feet. Over the remainder of Greene County the late Wisconsin drift lies at the surface and the soils formed on it are leached to depths of less than 3 feet. In some of the buried valleys of the county layers of till are interbedded with the outwash gravels. These till layers are important because in some places they confine water under artesian pressure, as in the Alpha-Trebein area. It is probable that at least some of these interbedded till layers were deposited by the early Wisconsin ice sheet and were covered by outwash gravels from the late Wisconsin ice.

The southward advance of the late Wisconsin ice sheet in Ohio was concentrated along two main valleys, the Scioto Valley in central Ohio and the Miami Valley in western Ohio (6). From these principal routes two great masses or lobes of ice spread outward and approached Greene County from two directions. The Scioto ice lobe spread westward across Greene County beyond the Little Miami River, where it met and joined with the ice of the Miami lobe that was pushing down from the northwest. The direction of former ice movement is shown by the location of the glacial deposits, by the origin of these deposits as indicated by the type of rock material they contain, and by the direction of glacial grooves or striae engraved in the bedrock by rock fragments carried in the ice. At New Jasper striae made by the ice of the Scioto lobe point almost due west. In the quarries near Osborn, striae left by the Miami lobe point in a south-easterly direction. The sources of the material in glacial deposits may be determined by stone counts in which the individual pebbles are identified and related to the outcrops of their parent formations. In Greene County the drift of both the Miami and the Scioto lobes consists chiefly of carbonate rocks, though the drift of the Scioto lobe contains a higher proportion of dolomite than that of the Miami lobe; drift of the Miami lobe is further distinguished by its fragments of lower Silurian (Brassfield) limestone and Upper Ordovician shale, outcrops of which lay in the path of the Miami lobe. Evidence based on several stone counts indicates that no drift brought by the Miami lobe occurs on the surface in Greene County east of the Little Miami River. On plates 10, 11, and 13 are shown the various positions of the ice sheets in Greene County during the times the principal deposits were formed.

There are only two types of drift or deposits left by any glacier. Material laid down directly by the ice as it wastes away is called till and occurs principally as ground moraine, or till plain. Till is a mixture of unstratified materials in which the individual particles range in size from clay or silt to boulders. Till is generally called "clay" or "hardpan" by well drillers. The other type of glacial deposits, commonly called outwash, consists chiefly of sand and gravel that have been carried and laid down in stratified layers by meltwater from the ice. Outwash materials have been roughly sorted by the water according to the sizes of the individual particles. They are generally deposited as kames, outwash plains, and valley trains. Plate 2 is a map of Greene County showing the types of glacial deposits covering the county.

Ground Moraine

The ground moraine in Greene County consists mostly of till deposited by the Scioto ice lobe. In most of the eastern half of the county the ground moraine obscures the underlying bedrock topography, producing a flat till plain. In the southern and southwestern parts of the county the ground moraine has been dissected by modern streams, and areas of strong relief have resulted. The ground-moraine deposits indicated on plate 2 as more than 20 feet thick range from slightly less than this figure to as much as 150 feet or more where they cover valleys. Ground moraine indicated as less than 20 feet in thickness may range from slightly more than this figure to a feather edge in areas of bedrock outcrops. Plates 8 and 9 show typical views of areas of thin and thick ground moraine in Greene County.

Till yields water to wells very slowly and most supplies developed in this material are taken from large-diameter dug wells. Such wells provide a large wall area for infiltration and a large storage space for the accumulation of water between periods of pumping. The average yield of these wells is generally adequate for hand pumps, but is seldom enough to supply electric-pump installations. In ground-moraine areas most drilled wells that do not penetrate the consolidated rocks obtain water from interbedded sand and gravel layers that occur in the till in some places. The yields of 55 typical wells in areas of thick till averaged 12 gallons a minute. The specific capacities of 38 of these wells averaged one-half gallon per foot of drawdown.

End-Moraine Till Deposits

End moraines are deposits that accumulated along the ice front where the front remained relatively stationary for a long time. Stabilization of the ice front occurred whenever a temporary balance was reached between the rate of melting. Such conditions of temporary balance probably occurred during periods when the ice was advancing over an area, as well as during periods of ice retreat, but only those morainal deposits that were formed during periods of retreat are well preserved. These halts of the ice front may have lasted a few decades or even a few centuries, but the time involved must have been relatively short compared to the total period of glaciation. End-moraine deposits generally consist of till in the form of hummocky ridges as much as a few miles wide and several to many miles long, rising 10 to 40 feet or more above the general level of the till plain. Most of the end-moraine deposits in Greene County were formed by the ice of the Scioto lobe, which moved in a westerly direction, and consequently the long axes of these deposits are aligned approximately north and south. An early halt of the Scioto-lobe ice occurred in the vicinity of Spring Valley and left a broad ridge, marked on plate 10 by a dotted line, which extends southeastward into Clinton County. This was followed by a retreat to the Cedarville, Xenia, and Caesar Creek Township areas, where the ice deposited a long line of hills, indicated by the solid line on plate 10. The last moraine deposited by the Scioto ice lobe in Greene County occurs in the form of a long, low ridge that extends north and south through Jamestown. This moraine is indicated by the easternmost solid line shown on plate 11. A photograph (pl. 8,E) of the

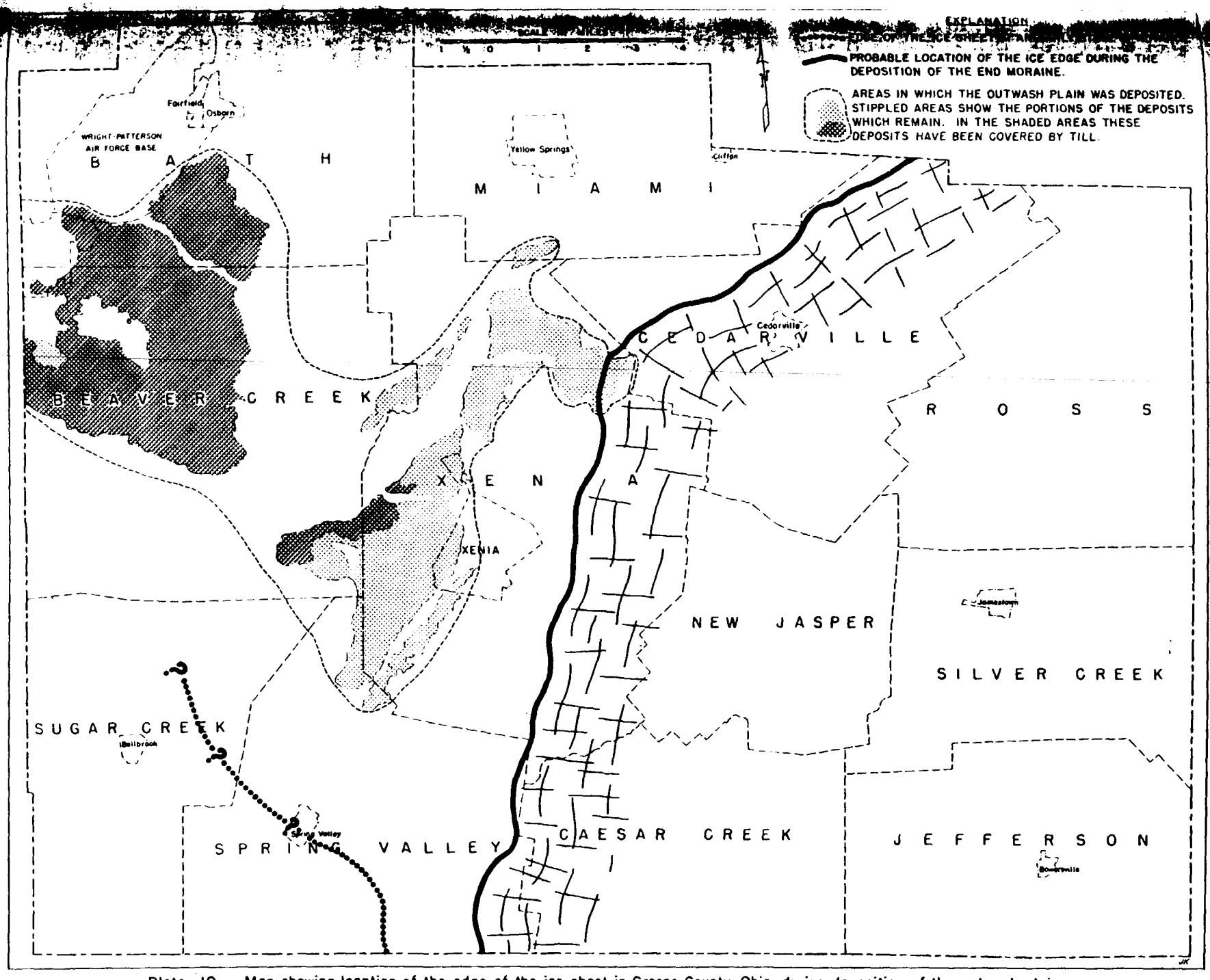


Plate 10. Map showing location of the edge of the ice sheet in Greene County, Ohio, during deposition of the outwash plain.

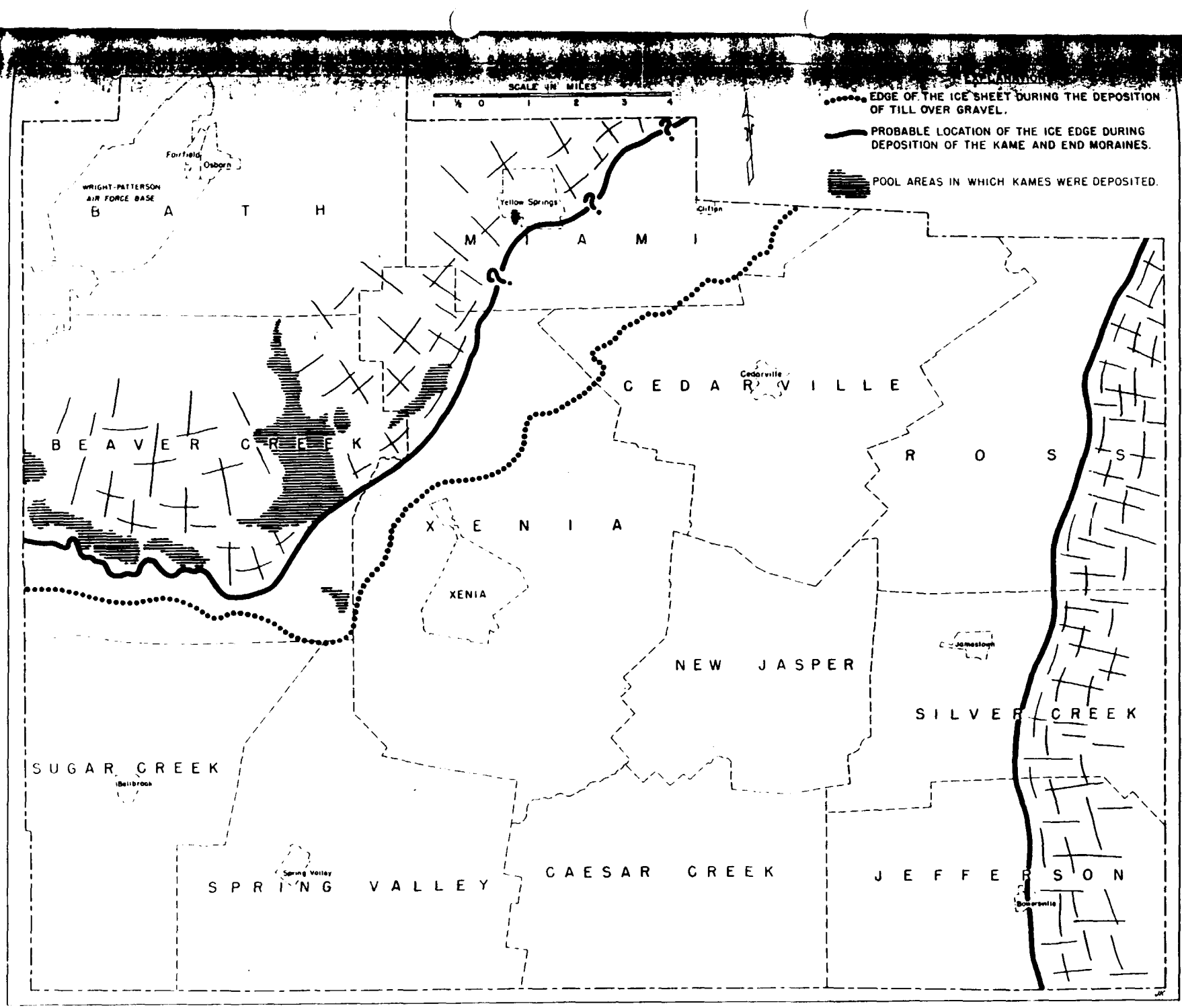


Plate 11. Map showing locations of the edges of the ice sheets in Greene County, Ohio, during deposition of till over gravel and formation of end moraine near Jamestown.

end moraine near Jamestown shows its relation to the general till plain.

The water-bearing properties of end-moraine deposits are similar to those of the ground moraine. Records of 31 drilled wells in end-moraine areas in Greene County showed their average yield to be 11 gallons a minute. In 18 of these wells the specific capacity averaged one-half gallon per foot of drawdown, the same as for 38 wells in ground-moraine deposits.

Kame and Kame-Moraine Deposits

Under certain conditions a glacier front may not undergo a systematic retreat, but the ice may melt off an area in an irregular manner, the front thinning to a ragged edge. In many such cases, outwash materials are deposited around the ice edge in the form of irregular mounds of sand and gravel called kames. In some areas kame deposits coalesce to form kame moraines. In northwestern Greene County the Miami ice lobe deposited kames along the sides of some of the preglacial valleys where the outwash-laden melt waters were confined between the ice edge and the valley walls. As indicated on plate 2, kame deposits form an irregular moraine that extends from the county line to the east past Zimmerman, along the eastern side of Beaver Creek Valley, and in the Little Miami Valley from Alpha to Yellow Springs. This kame moraine also extends westward into Montgomery County, where it has been described in the Southern Hills area south of Dayton (7). Kames were deposited in northwestern Greene County by the Miami lobe when the ice lay against the highlands south of the Mad River Valley. The probable position of the ice front when these later kames were deposited is shown on plate 11. A smaller area of kame deposits was also formed by the Scioto lobe ice in the extreme northeastern part of the county.

As shown in the photograph on plate 12, B, many kame gravels are coarse-textured and highly permeable, but, because these deposits were formed at generally high levels relative to the surrounding terrain, the water table is sometimes found at considerable depth below the surface and may even be below the kames themselves. Also, because kames are seldom traversed by large streams, supplies cannot usually be developed by induced infiltration. Initial yields of wells obtaining water from kame deposits, however, should be comparable to those tapping the outwash-plain deposits, which are among the best aquifers in the county. Records of six wells in kame areas showed their average yield to be 29 gallons a minute, more than twice as much as the average of 55 wells in ground-moraine deposits.

Outwash-Plain Deposits

In the early stages of its retreat, meltwaters from the Scioto lobe built an extensive outwash plain of sand and gravel to a comparatively high level in the area west of the town of Xenia in Xenia and Beaver Creek Townships. An outwash plain is formed in much the same way as kame deposits, by sediment-laden streams discharging their loads of sand and gravel at the wasting edge of the ice sheet.

However, an outwash plain is generally much more extensive than kames or kame-moraine deposits, and it differs from the latter in that its surface is comparatively flat (except where it has been dissected by later streams) and slopes or is graded in a direction away from the former ice front. According to Flint (8), the average grain size of outwash material also diminishes downstream, which is generally in a direction away from the former ice edge. As indicated on plate 10, the outwash plain must originally have covered a much larger area in northwestern Greene County then it does now, but subsequent erosion removed these deposits in some areas and, as a result of later advance of the Miami lobe, part of the deposits are covered by till in the area south of the Wright-Patterson Air Force Base. At the time the outwash plain was deposited the principal valleys must have been filled with ice to cause the discharging streams to flow at such high levels.

The water-bearing properties of the outwash-plain deposits are generally good, andthe initial yields of wells in these deposits are as high as for wells in the valley-train deposits, which are the best aquifers in the county. Because the outwash plain occurs at a comparatively high level, however, the water table is generally at a considerable depth below the surface. Also, because the outwash plain is not traversed by major streams, practically no possibilities exist for the development of infiltration supplies, and consequently the sustained yield of wells in these deposits probably would not be as great as that of wells in the valley-train aquifers. Good possibilities exist, however, for the development of small industrial or municipal supplies, perhaps as much as several hundred thousand gallons per day, from the better areas.

Valley-Train Deposits

A long, narrow body of glacial outwash confined within a valley is called a valley train. As the glaciers melted off Greene County, floods of meltwater poured down the valleys and deposited as much as 200 feet of stratified sands and gravels. The surfaces of the valley-train deposits grade in a direction away from the former ice front, with about the same slope as the gradients of the present streams that flow over these deposits. The principal courses of the glacial streams were down the Little Miami, Mad River, and Beaver Creek Valleys, as shown by the stippled areas on plate 13, which indicate areas in which outwash was deposited. The glacial streams did not deposit outwash materials everywhere along their courses, and locally they cut gorges in the bedrock where their gradients and velocities were very great. As indicated by arrows on plate 13, the gorges at Clifton, at Yellow Springs, at a point in the southern part of Beaver Creek Township, and at a point near Bellbrook were cut by glacial streams during the time most of the valley train deposits were being laid down. In the case of the Clifton and Yellow Springs gorges the waters merely deepened existing valleys. South of Alpha, however, the main valley was blocked by ice and the glacial drainage was forced to take a new course over the edge of the divide. This super-imposed stream cut a narrow gorge into the bedrock and outwash materials were carried through this channel into the wider part of the preglacial valley in the Bellbrook and Spring Valley areas. Southeast of Bellbrook, smaller gorges were also cut into the bedrock at this time by

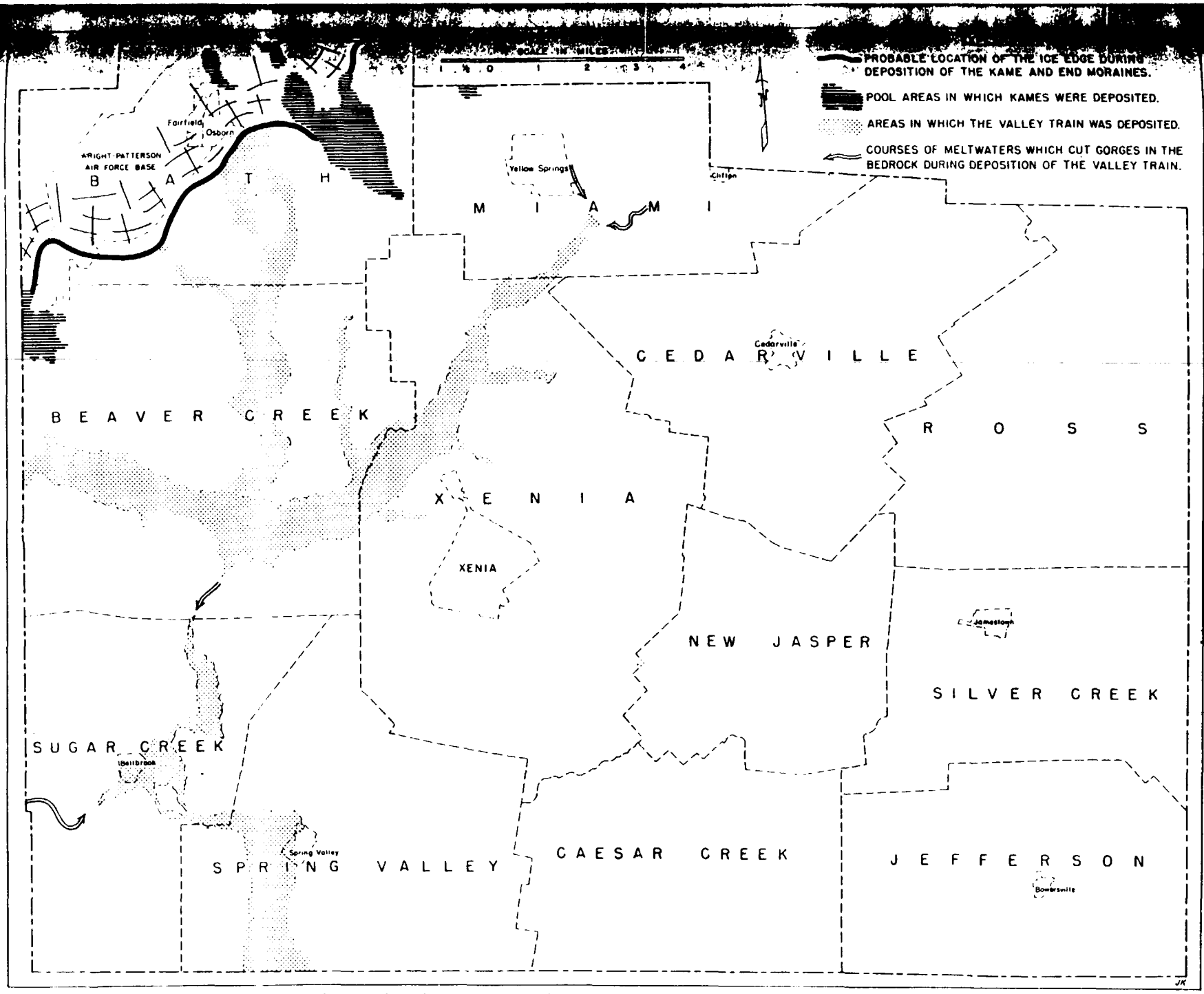


Plate 13. Map showing location of the edge of the ice sheet in Greene County, Ohio, during deposition of the valley train.

ice-diverted streams. Modern streams are now flowing over and cutting away the valley train, and in some areas they have removed considerable quantities of these deposits.

The best aquifers in the county are the sands and gravels making up the valley train. These deposits are almost everywhere coarse in texture and highly permeable. Individual wells yield as much as 2,000 gallons a minute, or even more, and where infiltration supplies can be developed close to the streams, as has been done in Montgomery County (5), several million gallons of water a day can be taken from small areas in these deposits without causing a progressive decline in water levels. At the Xenia municipal well field at Oldtown, the record of observation well Gr-1 indicates no continuous decline of water levels despite an average daily withdrawal of more than a million gallons. Undoubtedly the present yield from the Oldtown well field represents but a small fraction of its total capacity, as indicated by very much larger yields obtained from valley-train deposits in adjacent Montgomery County (5), where ground-water conditions are somewhat similar.

In many places layers or irregular lenses of till are interbedded in the sands and gravels of the valley train and in places these beds confine water under artesian pressure. In the Alpha-Trebein area coarse gravels occur below an extensive till layer that is found at depths of 80 to 100 feet below the surface. Water from this lower aquifer occurs under strong artesian pressure and rises in wells several feet above the land surface. It is probable that the chemical quality of the waters from the upper and lower valley-train aquifers is different, for in the Mad River Valley in adjacent Montgomery County, where two separate aquifers also occur in the valley train deposits, water from the lower aquifer is higher in iron and in total hardness (5) than water from the upper aquifer, which receives more direct stream infiltration.

Gravel Deposits Covered by Till

In a broad area centering south of the Wright-Patterson Air Force Base, the ground moraine overlies thick deposits of stratified sand and gravel. As indicated on plate 10, these buried outwash deposits probably were laid down by meltwaters from the Scioto ice lobe in the form of an extensive outwash plain, the remnants of which occur on the surface west of Xenia. After this outwash plain was laid down, the ice of the Miami lobe readvanced and deposited till to a maximum thickness of 100 feet or more over the stratified materials. On plate 11 is shown the probable position of the Miami lobe ice front during this readvance. A photograph of till over a gravel deposit appears as plate 12, A.

Wells in the till-over-gravel areas penetrate 10 to 100 feet or more of till before breaking into the water-bearing sands and gravels. When this occurs the water, which usually is under artesian pressure, rises rapidly in the wells to attain its static level. Supplies of water from these deposits are excellent for farm and domestic use, and are adequate for small industrial or municipal requirements.

Recent River Alluvium

Alluvium consists mostly of silts and sands deposited by the present streams on their flood plains during times they have overflowed their channels. The alluvium is thin, relatively impermeable, and generally not an important source of water. Wells commonly penetrate through these deposits into the valley-train deposits, which underlie the present streams in most areas.

GEOLOGY AND WATER-BEARING PROPERTIES OF THE CONSOLIDATED ROCKS

Stratigraphy and Structure

The consolidated rocks underlying Greene County are sedimentary in origin, having been laid down on the bottoms of large inland seas that at various times in geologic history have covered southwestern Ohio. These sedimentary rocks consist mostly of limestones and dolomites interbedded with and underlain by shales. Limestone is composed of calcium carbonate ($CaCO_3$) derived largely from the remains of marine organisms. Dolomite, which in physical appearance cannot be distinguished from limestone, consists of calcium and magnesium carbonate ($CaCO_3 \cdot MgCO_3$). Shale is formed by the consolidation of silt, mud, or clay. The consolidated formations that underlie Greene County from the surface to the depths commonly penetrated by deep wells drilled for oil or gas are listed in table 2, which gives the character of the formations, their thicknesses, and general water-bearing properties. Not all these formations are to be found everywhere in the county, some having been removed by erosion in certain areas, as shown on plate 1.

The formations listed in table 2 were originally deposited in a nearly horizontal position. In some areas, through elevation, subsidence, compaction, or faulting, they have become warped into domes, depressions, anticlines, or synclines The beds in such structures in Ohio generally dip only at low angles and the structures are important mainly for the different successions of strata that are brought to the surface in different regions. The most important structural feature of southwestern Ohio is the Cincinnati anticline, a broad arch whose center crosses the State from north to south and passes into Kentucky near Cincinnati. From Cincinnati the rocks dip gently to the east, north, and west. There is nothing in the surface relief or elevation to indicate this rock uplift; its presence is known only from geologic studies.

Greene County lies on the east flank of the Cincinnati anticline and in general the strata dip in a northeasterly direction. The elevation of the Brassfield limestone where it is exposed at the surface, or where its position is known from well data, was determined at approximately 10 places in Greene County by means of a surveying altimeter. The base of the Brassfield was found at elevations ranging from more than 950 feet in the southwestern part of the county to as low as 848 feet in the Yellow Springs well field, located about a mile north of the village. Some minor structural irregularities occur within the county, and locally the dip of the rocks deviates or is reversed from the regional trend. The inclination of the strata

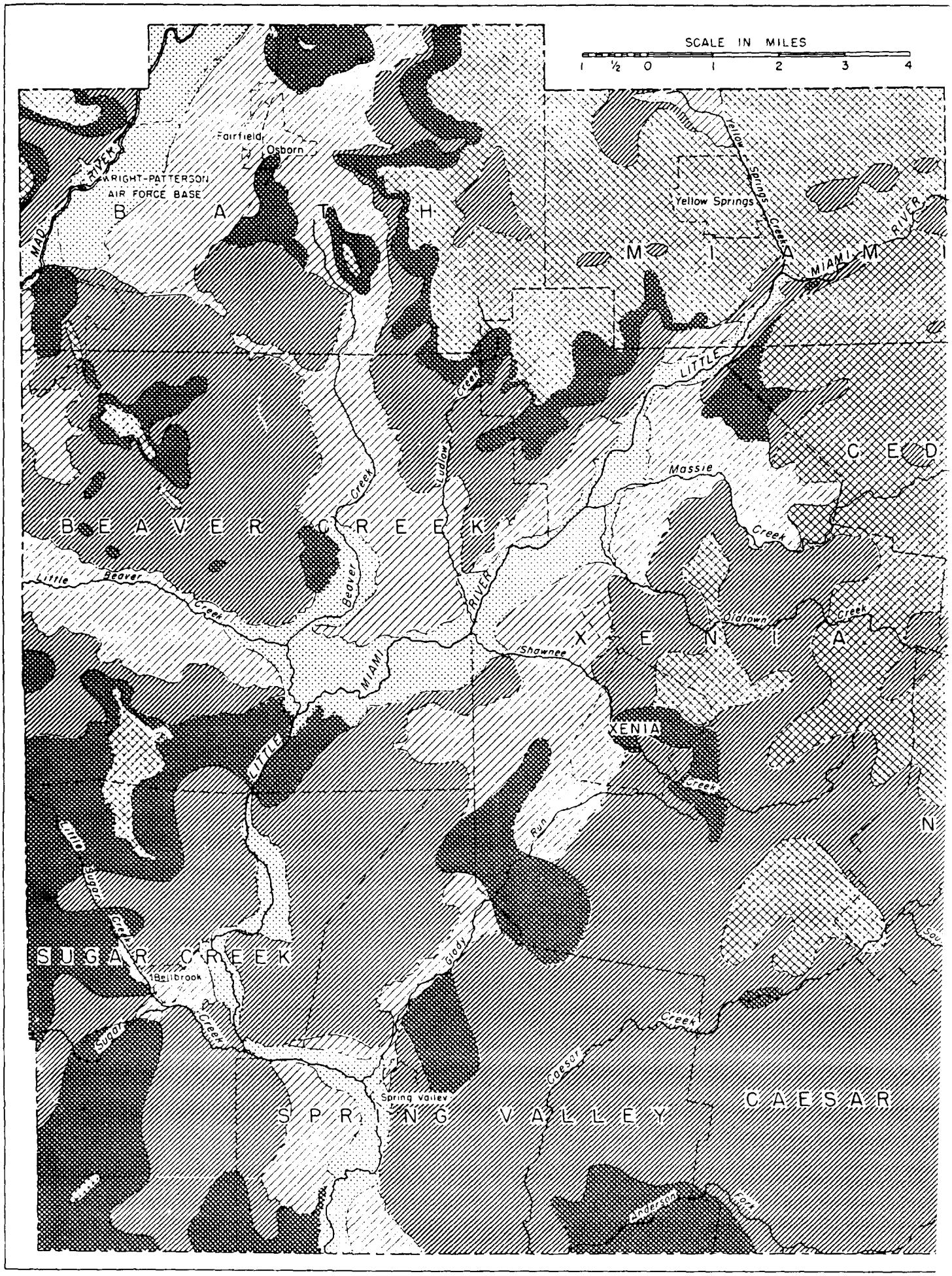
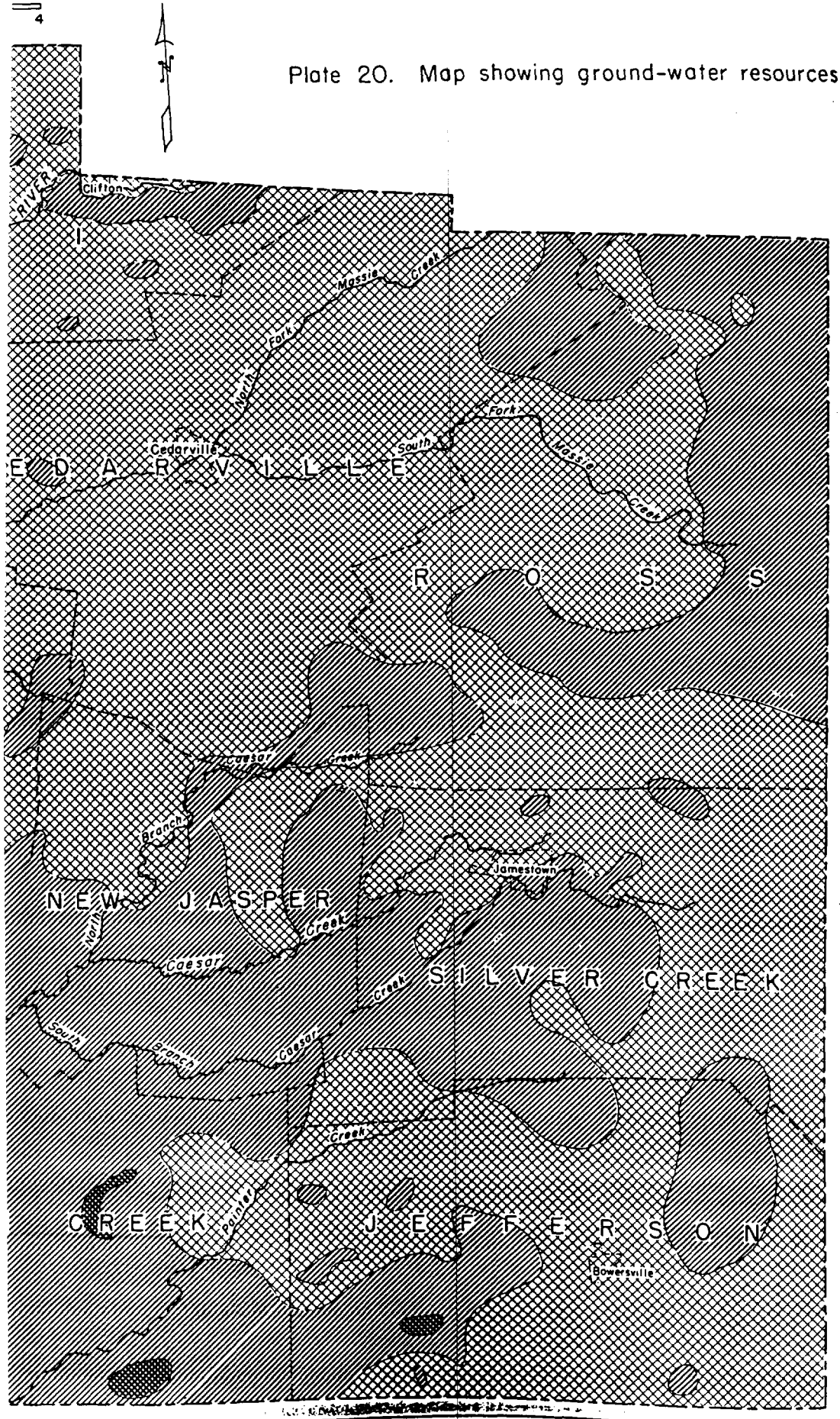

SCALE IN MILES
1 ½ 0 1 2 3 4
Fairfield
Osborn
WRIGHT-PATTERSON AIR FORCE BASE
MAD RIVER
B A T H
Yellow Springs
Yellow Springs Creek
MIAMI RIVER
LITTLE
Creek
Ludlow
C E D
Massie
Creek
B E A V E R C R E E K
Little Beaver Creek
Beaver
MIAMI RIVER
Oldtown Creek
X I E N I A
Shawnee
XENIA
LITTLE
Creek
Run
Little Sugar Creek
SUGAR CREEK
Bellbrook
Sugar Creek
Spring Valley
Glady
Creek
Caesar
S P R I N G V A L L E Y
C A E S A R
Anderson Fork

Plate 20. Map showing ground-water resources of Greene County, Ohio.



EXPLANATION

EXCELLENT SOURCE OF GROUND WATER

BEST GROUND-WATER AREAS. PERMEABLE SAND AND GRAVEL DEPOSITS TRAVERSED BY THE LARGER STREAMS. WELLS YIELD UP TO 2,000 GPM, OR MORE. LARGE SUSTAINED YIELDS FROM STREAM INFILTRATION.

GOOD SOURCE OF GROUND WATER

GOOD GROUND-WATER AREAS. PERMEABLE SAND AND GRAVEL DEPOSITS YIELDING UP TO 1,000 GPM, OR MORE TO WELLS. DEPOSITS ARE NOT TRAVERSED BY THE LARGER STREAMS AND THEREFORE INFILTRATION SUPPLIES CANNOT BE DEVELOPED.

GOOD TO FAIR SOURCE OF GROUND WATER

GOOD TO FAIR GROUND-WATER AREAS. WATER SUPPLIES GENERALLY OBTAINED FROM LIMESTONE AND DOLOMITE OF NIAGARA AND CLINTON AGE. BEST WELLS YIELD AS MUCH AS 150 GPM, OR MORE. SUPPLIES ADEQUATE FOR HOME, FARM, AND LIMITED MUNICIPAL OR INDUSTRIAL USE.

FAIR SOURCE OF GROUND WATER

FAIR GROUND-WATER AREAS. SUPPLIES GENERALLY OBTAINED FROM SAND AND GRAVEL DEPOSITS INTERBEDDED IN THE GLACIAL TILL. WELLS GENERALLY YIELD LESS THAN 25 GPM. EXCEPTIONAL WELLS YIELD UP TO 100 GPM, OR MORE. SUPPLIES ADEQUATE FOR FARM OR HOME USE.

POOR SOURCE OF GROUND WATER

POOR GROUND-WATER AREAS. IMPERMEABLE GLACIAL TILL OVERLYING THE NON-WATER-BEARING ORDOVICIAN SHALE. MOST SUPPLIES OBTAINED FROM DUG WELLS IN THE TILL. MANY DRILLED WELLS ARE FAILURES. WELLS GENERALLY YIELD LESS THAN 10 GPM.