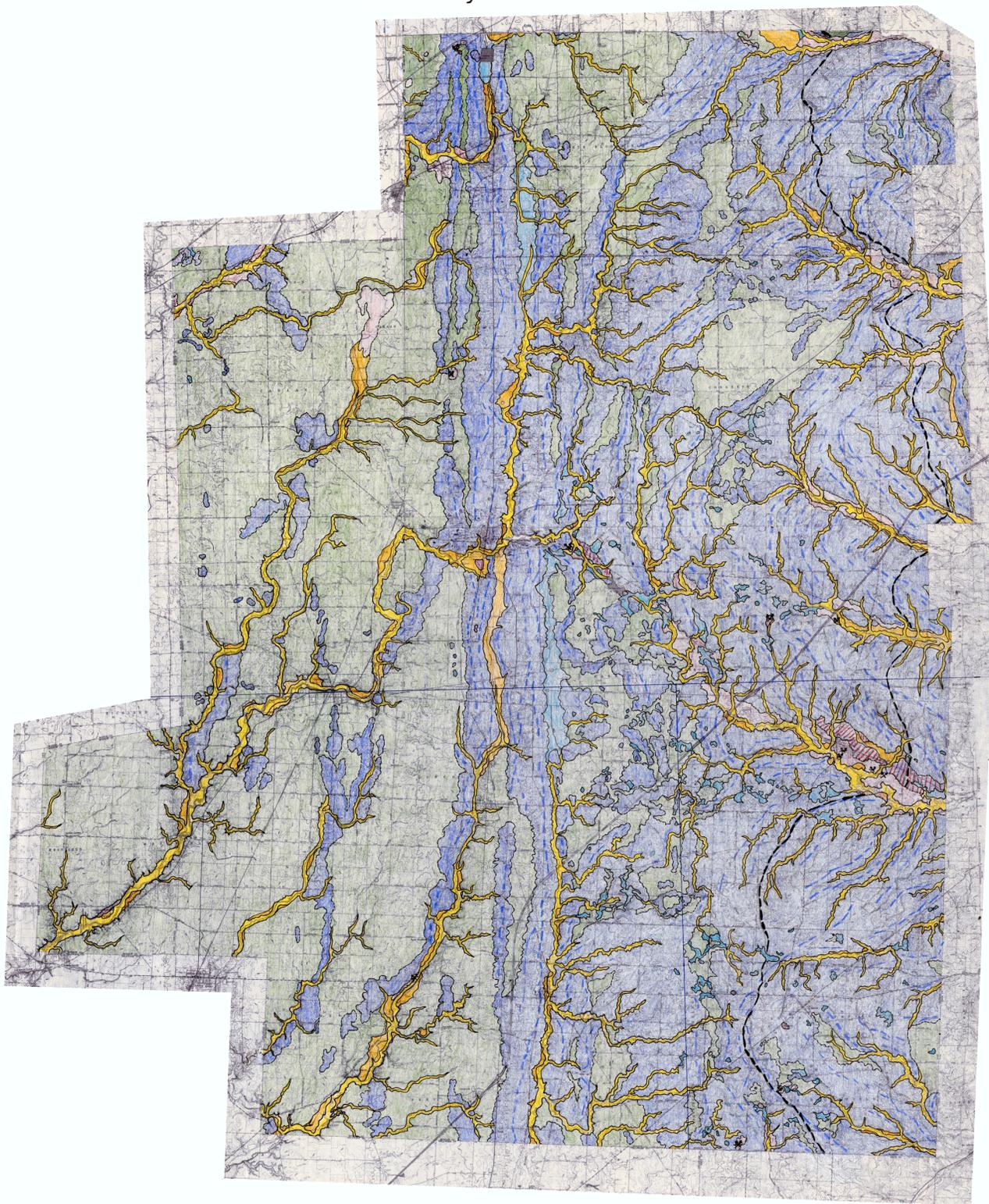


# Glacial Geology of Morrow County, Ohio

by  
Stanley M. Totten



Open-File Report 85-3  
Columbus 2017



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**Graphic design & layout:** David S. Orr

*Cover image:* Hand-drafted map of the glacial geology of Morrow County, Ohio, by Stan Totten.

*Recommended bibliographic citation:* Totten, S.M., 1985 [2017], Glacial geology of Morrow County, Ohio: Columbus, Ohio Department of Natural Resources, Division of Geological Survey Open-File Report 85-3, 118 p., 18 figs., 3 tables, 1 pl.

## FOREWORD

Stan Totten worked on both his M.S. and Ph.D. with Dr. George White who was at the University of Illinois in Champaign-Urbana. Together, they spent every summer in the 1960s and early- to mid-1970s field mapping glacial geology in Ohio, one county at a time. As White's health declined during the late 1970s, Totten's role increased.

After graduation from the University of Illinois, Totten taught at Hanover College in southern Indiana. While teaching at Hanover College, he continued working summers for the Ohio Geological Survey mapping about one county each year. He conducted fieldwork each summer and then wrote the report and manuscript during the school year. Totten was dedicated, often working 12-hour days all summer to complete the fieldwork.

Lab analysis on samples collected in the field were conducted by either the Survey's sedimentology lab in Columbus, by John Szabo at the University of Akron, or by Totten's students at Hanover College.

Four mapping staff members joined the Survey during 1983–1984, along with a lab technician for the sedimentology lab, to form a Quaternary mapping subsection within the Regional Geology Section. Three of the new staff members, Rene Fernandez, Rick Pavey, and I, were assigned Seneca, Erie, and Sandusky Counties, respectively, in western north-central Ohio.

During the early 1980s, Totten was assigned to map several counties in eastern north-central Ohio, essentially an area between that previously mapped by White and Totten in northeastern Ohio and that being mapped by the newer staff members. Totten was tasked with extending westward the stratigraphic nomenclature used for the eastern Killbuck Lobe in Ashland, Medina, and Richland Counties, linking with mapping being done by the Quaternary mapping subsection. He mapped Crawford, Hardin, Huron, Lorain, Marion, and Morrow Counties during this period. Additional impetus for mapping in Morrow County was the result of research done for the field trip guidebook for the 1987 Midwest Friends of the Pleistocene Field Conference, which centered on Knox, Morrow, and Richland Counties.

Totten produced manuscript reports and draft maps (at a scale of 1:62,500) for each of these counties. The original goal was to publish a report of investigations for each county map and report that Totten produced, as well as the county maps and reports being produced by the Quaternary mapping subsection.

The maps and manuscripts were left unpublished for a number of reasons:

- The Survey encountered funding problems during the late 1980s, and the printing process was very expensive for both the maps and bound reports.
- The cartographic work for producing the maps was totally manual and involved an elaborate process of creating photographic negatives for base maps, peel-coats, scribing, type-setting and other steps that took a team almost a year to produce one map. And since there was inadequate cartographic staff to produce the maps and reports, this level of detail and completion was not provided for all the counties.
- Totten's ability to create tables, captions, and figures was very limited by the technology of that time, thus all this work fell on the editorial and graphics section.
- USGS funding supported reconnaissance-level mapping at a regional scale, and the concept of county-based maps and reports was abandoned by the Survey in favor of 30 x 60-minute quadrangle-based mapping initiatives. This was done to meet USGS standards being introduced nationally at that time.

It should be noted that these maps and reports are scanned as-is and may include typos, errors, editorial notes, and other marks. Maps are largely hand-colored and may represent the "final" of several versions. Legends accompanying the maps also may be hand-colored.

The Survey feels that these manuscripts may be of value to the public, academia, and perhaps consulting/geotechnical geologists. The reports contain a tremendous amount of particle size and mineralogical data and in-depth discussions of the materials and stratigraphy. The maps depict only the uppermost surficial materials and geomorphology, and they are very detailed. The maps and reports are of value to those who might need info on the background geology of a specific county, are doing detailed work in the county, or have a keen interest in the glacial geology of north-central Ohio.

Mike Angle  
May 24, 2017

Glacial Geology  
of  
Morrow County, Ohio

by  
Stanley M. Totten  
1985

GLACIAL GEOLOGY OF MORROW COUNTY, OHIO

by

Stanley W. Totten

Glacial Geology of Morrow County, Ohio  
Stanley M. Totten

Explanation

Recent

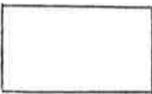


Alluvium. Silt, sand and gravel in stream channels and on floodplains. Thickness is highly variable.

Wisconsinan



Alluvial Deposits. Silt, sand and gravel of variable thickness deposited in valleys and preserved as terraces along valley sides. Mainly valley train deposits of glacial outwash.



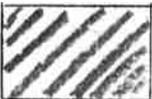
Lake Deposits. Sand, silt, clay, muck and peat of variable thickness deposited in kettle holes and in valleys dammed by end moraines.



Kames and Kame Terraces. Gravel and sand in knolls or in terraces; overlain by till in many places.



End Moraine. Hummocky topography having linear trend. Thin Centerburg and Mt. Liberty tills at surface underlain by older tills. Bulk of moraine consists of Jelloway Till.



Gravelly Moraine. Knolls consisting of till at surface, with masses of gravel likely at depth.



Ground Moraine. Gently rolling topography. Thin Centerburg and Mt. Liberty tills underlain by older tills.



Gravel Pit, active



Gravel Pit, small or abandoned



Centerburg Till boundary (approximate)



Crestlines of end moraine elements

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## PLATE

1. Glacial deposits of Morrow County, Ohio

## INTRODUCTION

Morrow County is located in the heart of Ohio: The geographical center of Ohio, in Centerburg, is located only three miles south of the Morrow-Knox county line. Columbus, the capital of Ohio, is located 25 miles south of the southern border of the county, and Mansfield is located about eight miles northeast of the county. Morrow County, one of the last counties to be formed in Ohio, was formed in 1848 from parts of Richland, Knox, Delaware, and Marion counties. The county is bounded on the north by Crawford and Richland counties, on the east by Richland and Knox counties, on the south by Knox and Delaware counties, and on the west by Delaware and Marion counties. The county lies between  $82^{\circ}38'$  and  $83^{\circ}$  west longitude, and  $40^{\circ}20'$  and  $40^{\circ}43'$  north latitude. It is a relatively small county with maximum dimensions of 20 miles from east to west and 25 miles from north to south, for a total area of 404 square miles and 258,560 acres. It is largely rural with a relatively small population (1980 Census) of 26,476, which represents an increase of 24% over the 1970 population. The county seat and largest village is Mt. Gilead (pop. 2894), followed in size by Cardington (pop. 1665), Edison (pop. 509), Fulton, Marengo, Chesterville, and Sparta. The major industry in the county is agriculture, and the recent increase in population is a result of the migration of considerable numbers of persons away from the nearby cities of the country. Interstate 71 which connects Columbus and Mansfield cuts across southeastern Morrow County.

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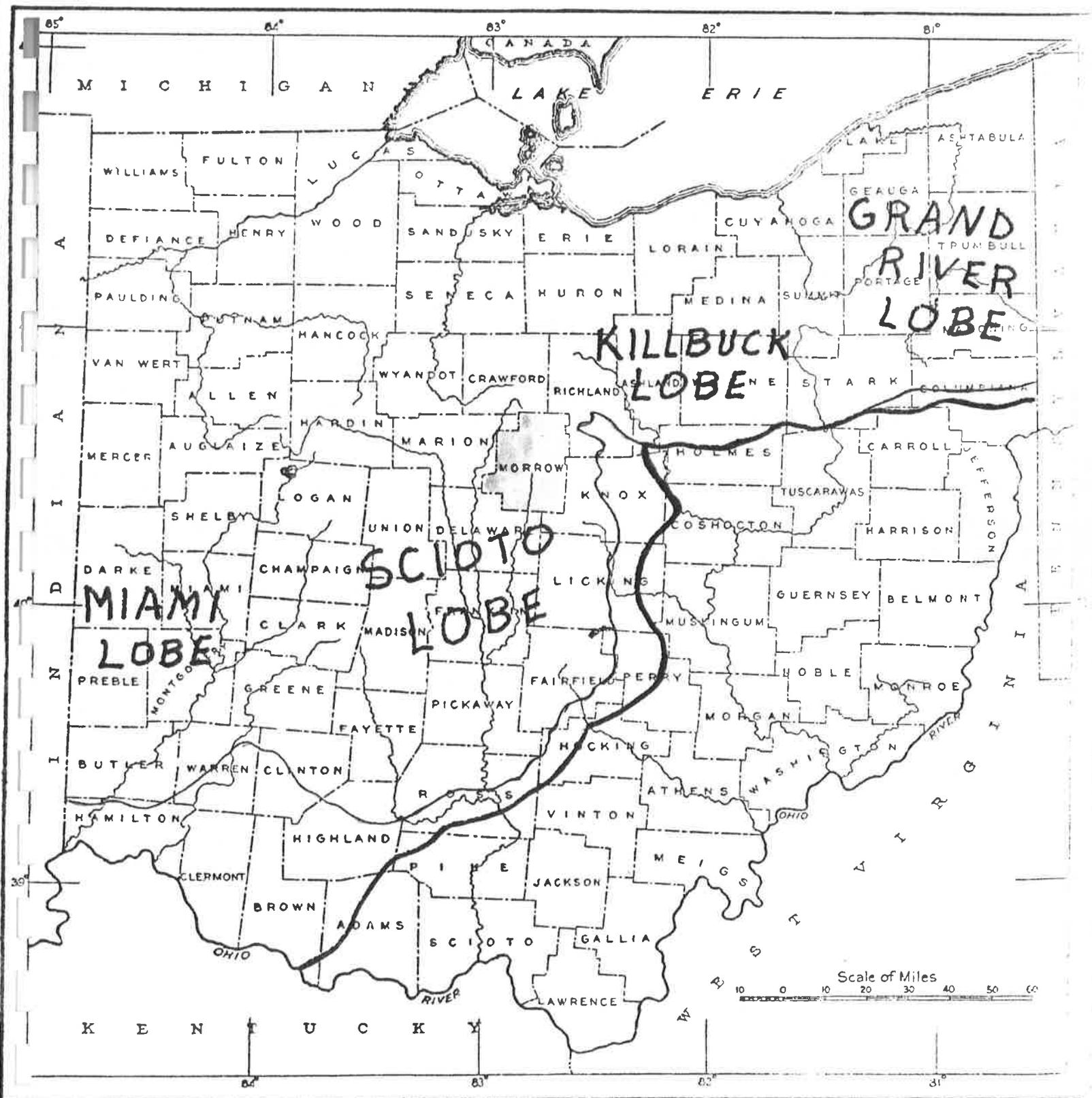


Figure 1. Map showing location of Morrow County, glacial boundary (heavy line), Woodfordian drift boundary (light line), and glacial lobes.

The county is bisected by the Greenville Treaty Line, south of which the county was not surveyed by the Township and Range system. The highest elevation in the county is 1485 feet in Troy Township in the northeastern part of the county. The lowest elevation is 907 feet where Alum Creek flows out of the county at the Morrow-Delaware county line.

Topographic map coverage for Morrow County is included on the following 7½ minute maps: Ashley, Bellville, Blooming Grove, Caledonia, Centerburg, Chesterville, Denmark, Galion, Kilbourne, Marengo, Mount Gilead, Olive Green, and Waldo.

## ACKNOWLEDGMENTS

This report is based on a detailed field study conducted in 1984. Supplementary materials useful in preparing this report included air photos, water well records, and soil maps. Richard Gehring of the Soil Conservation Service provided field sheets of the soil mapping project which was in progress when this report was prepared. Till samples were analyzed at the University of Akron under the supervision of John Szabo. Joel Vormelker of the Geological Survey provided the drift-thickness map based on water well records. Dennis Hull of the Geological Survey has provided valuable support and encouragement in the development of this report.

## PURPOSE AND SCOPE

4

This report describes the glacial drift, the surface material overlying the bedrock. Stratigraphy of the deposits and the morphology of the land forms are described and correlated with deposits and surface features in adjacent counties in Ohio. Economic resources of the deposits are considered, and suggestions are made for their utilization and conservation.

This report will be of interest to various groups and individuals: Highway engineers, construction firms, sand and gravel operators, soil scientists, architects, and city planners. Citizens who are, or will be responsible for planning and shaping the future of Morrow County for agriculture, urbanization, recreation, and industrialization will find this report useful for making their decisions.

## PREVIOUS INVESTIGATIONS

The earliest report on the geology of Morrow County was by Winchell in 1874 (p 253-271) who described the surface features, drift, bedrock, and economic deposits. Winchell stressed the bedrock in his report, and he included valuable data on the numerous sandstone quarries in the county.

Leverett (1902) in his monograph on the Erie Glacial Lobe mentioned Morrow County glacial features in briefest terms. Leverett's (1902, Plate 13) glacial map of the Scioto Lobe showed a distribution of moraines in Morrow County that bears a close resemblance to the map (Plate 1) included with this report. Leverett's (1902) moraine mapping was revised by White (1935) and incorporated in the Glacial Map of Ohio (Goldthwait, et al, 1961). The drainage history of Morrow County was included in reports by Coffey (1958), White (1934), and Stout and others (1943). The principal sources of information regarding water supply are the report by Stout and others (1943) and the map by Kostelnick (1981). The economic resources of Morrow County have been discussed by Hall and Alkire (1956). The detailed soil report by Gehring and others (in preparation) is a useful reference in the study of the surficial materials.

Reports on adjacent counties provide information on glacial deposits at or near the margin of Morrow County. There are reports on Knox County (Root, Rodriguez, and Forsyth, 1961) to the east, Richland County (Totten, 1973) to the northeast, and Crawford County (Totten, in preparation) to the north.

PHYSIOGRAPHY

Topography

Most of Morrow County has a gently undulating to moderately hilly topography that is both scenic and adaptable to a variety of uses. The glacial topography varies from nearly flat to gently undulating in the ground moraine (Plate 1) to hummocky and moderately sloping in the end moraines. The glacial drift is sufficiently thick to obscure most of relief in the underlying bedrock surface. Only the broad slope of the Allegheny escarpment is recognizable beneath the thick drift cover. This escarpment played a major role in influencing the style of glaciation in the county. The highest elevations in Morrow County are near the eastern border of the county at the crest of the escarpment where several moraines are stacked on and against one another. The lowest elevations are in the western part of the county in front of the escarpment. The escarpment represented a drainage divide from preglacial times to the present. Several streams, destined to become major drainage lines, originate in the upland of northeastern Morrow County. Consequently, the valleys of these very youthful streams are small, and postglacial erosion has had little effect on the topography of Morrow County.

The Allegheny escarpment is a broad westward facing slope which rises about 400 feet in a distance of eight miles. The rise is both broad and gradual, so gradual that the casual observer may not be aware of the significant change in elevation. The highest elevation in the county, estimated to be 1485 feet, is in the Johnstown morainic complex of eastern Troy Township

a short distance west of the Morrow-Richland county line. The lowest point in the county, estimated to be 907 feet, is in the bottom of Alum Creek valley in southwestern Peru Township at the Morrow-Delaware county line. Whetstone Creek in the southwestern corner of Westfield Township has an elevation of 910 feet. Thus the total available relief in the county is 578 feet. The steepest slopes in the county are along river bluffs where the nearly vertical slopes range from a few feet high to as many as 70 feet in height. The highest valley walls include Sams Creek (70 feet) east of Mt. Gilead, Whetstone Creek (50 feet) at Cardington, and Alum Creek (50 feet) in Peru Township. In the hummocky morainic area in the northeastern part of the county, the maximum relief south of Clear Fork Reservoir is about 280 feet per mile, and near Johnsville (Shauk) the relief is 200 feet per mile.

## Physiographic Provinces

### General Statement

Morrow County lies within two major physiographic provinces—the Central Lowland and the Appalachian Plateau (Fenneman, 1928, 1938). In Fenneman's classification, the western part of the county is located in the Till Plain section of the Central Lowland, and the eastern part of the county is located in the Allegheny Plateau section of the Appalachian Plateau. White (1934; 1935) recognized an intermediate section which he named the Low Plateau between the Till Plain and Appalachian Plateau. All three of these sections trend north-south in Morrow County, and each section comprises about one-third of the total area of the county (fig. 2).

### Till Plain

The Till Plain of western Morrow County (fig. 2) is a relatively featureless plain marked by a few low knolls of end moraines and by several relatively small valleys. Two of the streams, Alum Creek and Whetstone Creek, have entrenched their valleys as much as 50 feet below the Till Plain surface. The eastern margin of the Till Plain section is marked by the western border of the Broadway moraine in the northern part of the county, and by the western border of the Powell moraine in the southern part of the county. The nearly level surface of the Till Plain was formed during several glacial advances during which several layers of till were deposited as ground moraine. The drift of this section has a thickness varying from 25 to 50 feet; and the drift overlies a bedrock surface of low to

moderate relief cut into the Ohio shale of Devonian age. In Morrow County, the Till Plain slopes gently westward 12 to 15 feet per mile. Surface elevations range from 960 to 1000 feet at the Marion-Morrow County line in the west to 1060 to 1100 feet near in the east adjacent to the moraines. Knolls of the Mississinewa and Broadway moraines rise gently 15 to 25 feet above the Till Plain surface on which they occur.

Low Plateau

The Low Plateau section as recognized by White (1934, 1935) represents a transition zone between the relatively flat Till Plain and the relatively hilly Allegheny Plateau (fig. 2 ). This transition zone ranges from 4 to 10 miles in width, and has a pronounced westward slope. Elevations along the western margin of the section generally are 1060 to 1100 feet, whereas the eastern part of the section has elevations ranging from 1300 to 1400 feet. As best seen in cross-section, <sup>(fig 3)</sup> the Low Plateau represents a drift-mantled escarpment developed in the resistant sandstones of the Berea and Cuyohoga formations. This escarpment, actually a double scarp formed by the lower Berea escarpment and the higher Allegheny escarpment, represented a 400 foot high barrier to the advance of ice sheets into central and eastern Morrow County. This barrier did not stop the flow of ice over the Low Plateau, but it did influence greatly the style of glaciation in the county. A thick wedge of drift, averaging over 100 feet in thickness was deposited on and against the escarpment, and numerous moraine elements (Plate 1) occur closely juxtaposed on the escarpment (fig. 3 ). The moraine topography, which dominates the Low Plateau, is hummocky to gently rolling. Slopes range from gentle to steep, with the steepest slopes 70 feet or more high occurring near river valleys.

Allegheny Plateau

The eastern part of Morrow County lies in the relatively hilly Allegheny Plateau section. In areas adjacent to Morrow County (White, 1934, 1935), the Allegheny Plateau has been dissected from 200 to 400 feet by streams which have cut through the resistant sandstones of Mississippian and Pennsylvanian age. In Morrow County the dissected bedrock surface has been buried beneath thick drift, and the modern surface is dominated by morainic knolls of low to moderate relief (fig.3 ). Local relief in the Allegheny Plateau in the northeastern part of the county exceeds 250 feet, but in most places, the topography is similiar to the Low Plateau where the local relief averages 25 to 50 feet. Most of the Allegheny Plateau in Morrow County exceeds 1300 feet in elevation, and several morainic ridges exceed 1400 feet in elevation. Most of the streams in eastern Morrow County are small, and relatively little postglacial dissection of the moraines has occurred. As a result of the thick drift and slight dissection, bedrock is rarely exposed anywhere in the Allegheny Plateau of Morrow County.

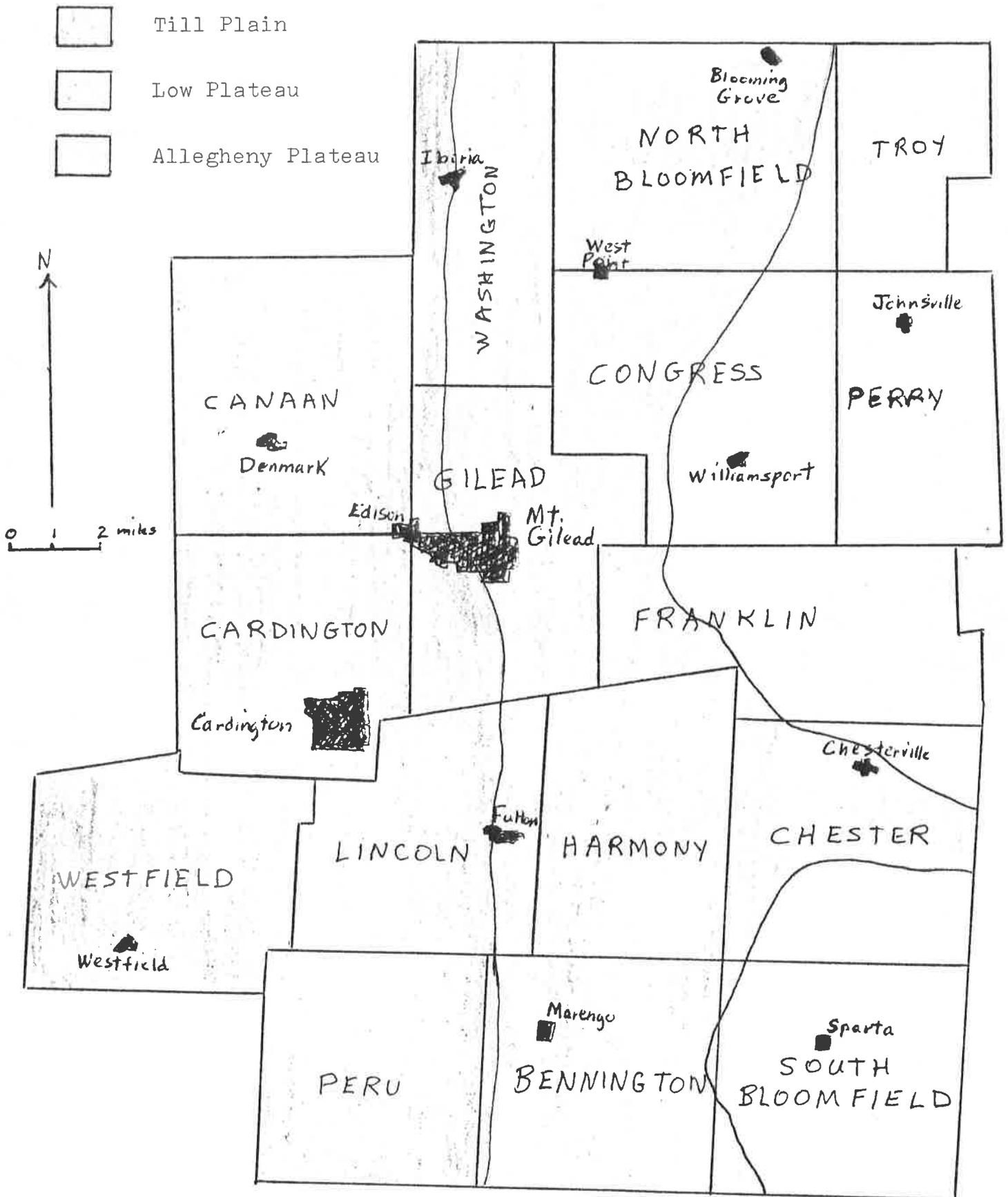


Figure 2. Physiographic divisions of Morrow County

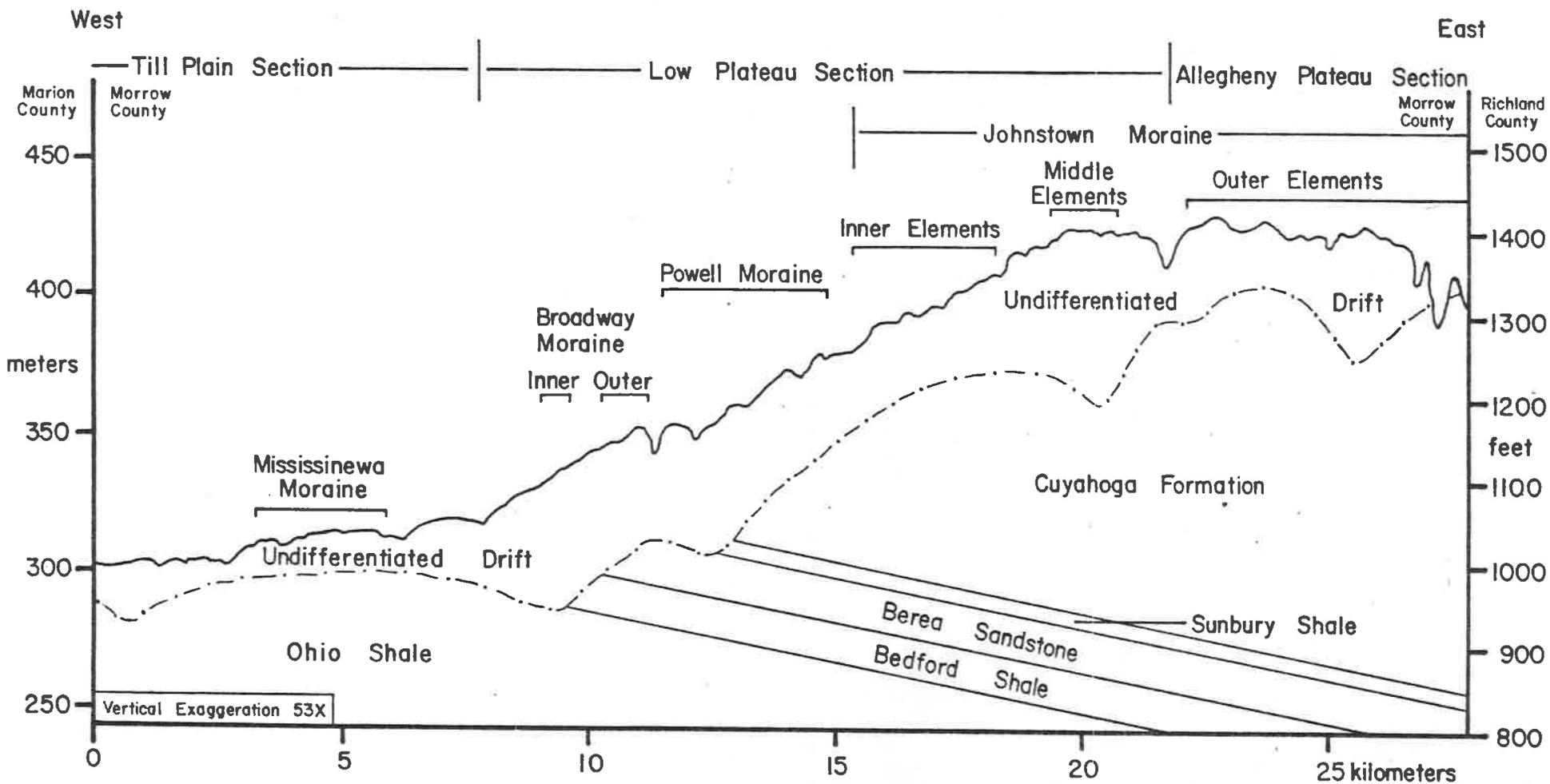


Figure 3. Cross-section of Morrow County at  $40^{\circ}35'10''$  North Latitude. Dashed line represents the bedrock surface.

## Drainage

### Modern Drainage

#### General Statement

The modern drainage lines of Morrow County describe a most unusual and irregular pattern. Many streams appear to be aimlessly wandering across the countryside, in some places making nearly circular loops, in other places making abrupt right angle bends. The complex tangle of drainage lines is a result of complex morainic topography in eastern Morrow County, compounded by derangement of drainage from several ice advances and retreats. The headwaters of six major streams occur in Morrow County (fig. 4). Four streams, the Olentangy River, South Branch Clear Fork, Cedar Fork, and Whetstone Creek, originate in an area of about two square miles in the Johnstown moraine of east-central North Bloomfield Township. All of the streams in the county are small, yet several have intrenched their channels as much as 50 feet into drift and bedrock.

#### Kokosing River Basin

The Kokosing River drains a large area of eastern and southeastern Morrow County including much or all of Congress, Perry, Franklin, Chester, and South Bloomfield Townships. Headwaters of the Kokosing River are near Williamsport in and amongst the knolls of the Johnstown moraine in southeastern Congress Township. The river winds and twists its way southward between elements of the moraine to Harmony Township where it intersects the large partially buried valley of the preglacial Kokosing River. From Harmony Township, the Kokosing River meanders

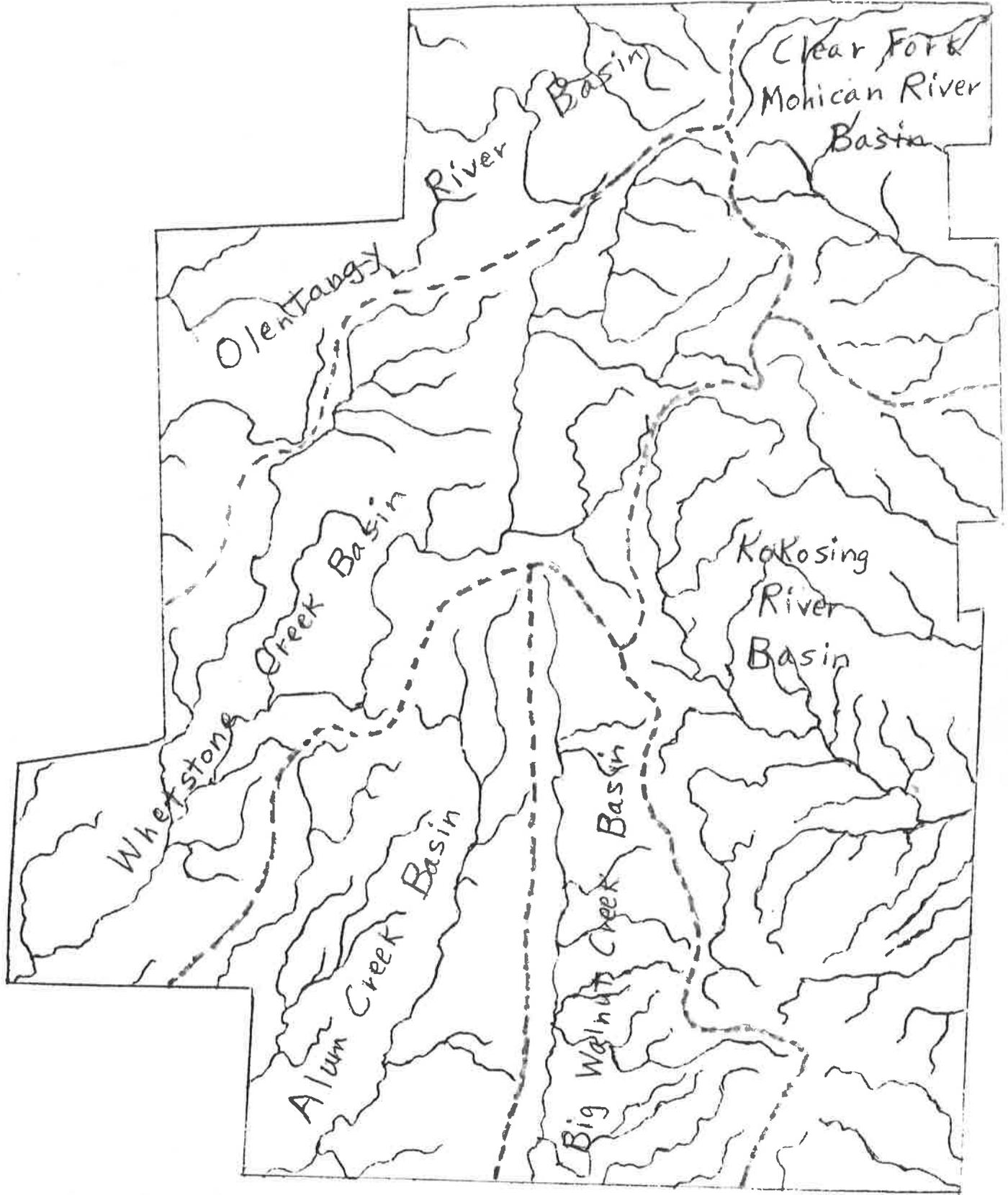


Figure 4. Modern drainage of Morrow County  
 Drainage divides shown by dashed lines.

southeastward across northern Chester Township to Knox County. The postglacial Kokosing River managed to reestablish its old course even though the valley was plugged in several places with large quantities of drift including 10 or more morainic ridges of the Johnstown moraine. Prior to postglacial time, the Kokosing River valley contained a series of lakes, ponds, and swamps which formed behind the morainic dams. Lake sediments, consisting of peat, muck, silt, and clay accumulated in the depressions and are encountered by borings in many places within the valley in Chester Township. Major tributaries of the Kokosing River from the south are South Branch and Mile Run which originate in South Bloomfield Township. Major tributaries from the north include Sylvester Run, North Branch, and Lost Run.

Clear Fork Mohican River Basin

Two tributaries of Clear Fork, South Branch and Cedar Fork, originate in the northeastern corner of Morrow County. Clear Fork has been dammed in adjacent Richland County, and a portion of the south shore of the Clear Fork Reservoir occurs in the extreme northeastern corner of the county. South Branch of Clear Fork originates in the high knolls of the Johnstown moraine in eastern North Bloomfield Township, from where it flows northward and eastward to the reservoir. Cedar Fork flows southeastward across the southwestern corner of Troy Township and the northeastern corner of Perry Township into Richland County.

### Olentangy River Basin

The Olentangy River drains the northwestern corner of Morrow County including major parts of North Bloomfield, Washington, and Canaan Townships. Headwaters of the Olentangy River are in the Powell moraine near Blooming Grove at the north edge of the county. The Olentangy River flows northward into Crawford County, and then makes a large loop to the west and south outside of Morrow County. Several small streams in Canaan and Washington Townships flow westward into Marion County where they are tributary to the Olentangy River.

### Whetstone Creek River Basin

Whetstone Creek, which is tributary to the Olentangy River in Delaware County, also has its headwaters in North Bloomfield Township within about 2 miles of the Olentangy River headwaters. Whetstone Creek makes several right angle bends as it flows generally in a southwestward direction. From its headwaters, Whetstone Creek flows southward for  $3\frac{1}{2}$  miles along the eastern margin of the Powell moraine, makes a  $90^\circ$  bend westward crossing all 3 ridges of the Powell moraine, and bends southward again following the depression between the Powell and Broadway moraines for 5 miles to Mt. Gilead. At Mt. Gilead, Whetstone Creek bends westward, crosses the 3 ridges of the Broadway moraine, and bends southward as it flows toward Cardington. Near Cardington, the stream makes its final bend westward, crosses 2 weak elements of the Mississinewa moraine, and bends southwestward toward Delaware County where it flows into the Olentangy River. Major tributaries of Whetstone Creek are Shaw Creek which drains parts of Cardington, Canaan, and Gilead townships, East Branch which drains a part

of Congress Township, and Big Run which drains a portion of Cardington and Gilead townships.

#### Alum Creek Basin

Alum Creek originates in the Powell moraine 1 mile south of Mt. Gilead, and it flows southward for 3 miles within the confines of a broad outwash channel situated between the Broadway and Powell moraines. Alum Creek is bounded on the west by the Broadway moraine for its entire 16 mile south-southwestward course in Morrow County. Consequently, nearly all of its tributaries in the county enter from the ground moraine area to the east. Two major tributaries to Alum Creek, West Branch and Turkey Run, have headwaters in Lincoln Township and follow southwestward courses nearly parallel to Alum Creek. Two small streams tributary to Alum Creek, Bunkey Run and Indigo Creek, flow westward and drain western Bennington and eastern Peru townships.

Big Walnut Creek Basin

Big Walnut Creek originates in a hummocky area of the Johnstown moraine near the center of the county  $1\frac{1}{2}$  miles east of Mt. Gilead. Big Walnut Creek flows southward for  $12\frac{1}{2}$  miles in Morrow County confined to depression between the prominent Powell moraine to the east. Its numerous tributaries in Harmony and Bennington Townships are westward flowing and include Castro Run, Mill Creek, Light Creek, and Reynolds Run.

## Pleistocene Drainage Systems

The Pleistocene and pre-Pleistocene drainage history of Morrow County is complicated and many details are imperfectly understood. Several drainage changes are known in the county, and these changes are associated with advance and retreat of ice coupled with the formation of a series of end moraines. The moraines served as earthen drains which blocked stream flow, in places temporarily, in places permanently. White (1934) presented evidence that the major preglacial divide in Ohio extended in an east-west direction across northern Morrow County, but he was of the opinion that the preglacial valleys were at higher elevations than at present. White's (1934) interpretation suggests that the system of buried valleys (fig. 5) originated in the Pleistocene, and is not a preglacial system.

The Allegheny escarpment represents a prominent north-south bedrock divide which likely influenced preglacial drainage to a greater extent in pre-Pleistocene time than it does today. Water well records do not indicate any major valleys cutting through the escarpment. It is unlikely that the major preglacial drainage in Morrow County prior to the Pleistocene was westward across the escarpment. Instead, it is likely that both east-west and north-south trending divides existed in Morrow County prior to the onset of glaciation, and the preglacial (Teays Stage) drainage may not have been much different from the present buried valley system revealed by well records. The earliest (Nebraskan?) glacier to reach north-central Morrow County blocked the northward and westward flowing streams and diverted the drainage southward and eastward.

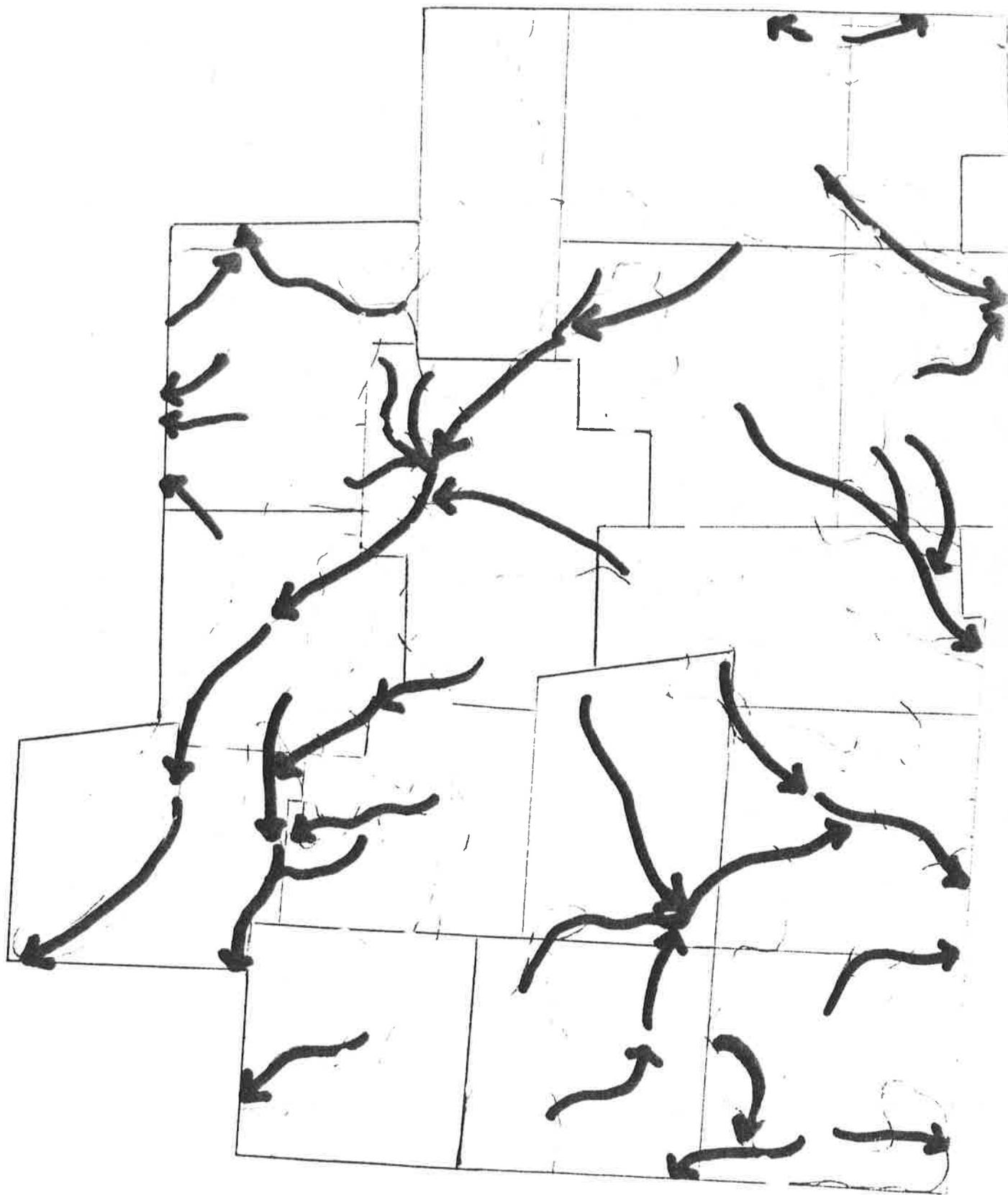


Figure 5 Buried valley systems of Morrow County  
(Based on bedrock contour map by Joel Vormelker)

However the Allegheny escarpment in Morrow County was too high to allow eastward diversion of drainage; Thus the major diversion was southward.

During the onset of Kansan glaciation, deep valley cutting, known as "Deep Stage", occurred in many areas of Ohio, and deep dissection probably occurred in eastern Morrow County at that time. Stout and others (1943) named the two southward flowing deep stage rivers that drained Morrow County the Utica and Columbus rivers. The Deep Stage valleys in eastern Morrow County are buried by 300 or more feet of drift. Following the formation of the Deep Stage valleys, valley filling became dominant during the middle and late Pleistocene. Most notable of the valley filling episodes was the Jelloway glaciation (40,000-35,000 BP) during which a series of end moraines (Totten, 1969) were deposited across the major valleys. The pre-Jelloway drainage was deranged and significantly modified as can be seen by the contorted, poorly integrated modern drainage.

## Bedrock

The bedrock underlying the drift in Morrow County is composed primarily of shale, siltstone, and sandstone of Devonian and Mississippian age (fig. 3). These rocks dip gently toward the east at approximately 20 feet per mile. The oldest rock exposed in the county is the Ohio Shale of Devonian age which occurs in the western part of the county known as the Till Plain section (fig. 3). Exposures of the Ohio shale occur along Alum Creek, Whetstone Creek, and several of their tributaries primarily in the southwestern part of the county. Some deep water wells in the southwestern part of the county reach limestone which occurs beneath the Ohio Shale. This limestone is not exposed in Morrow County, but is exposed to the west in Marion County.

Shale and sandstone of Mississippian age underlie the drift in the Low Plateau and Allegheny Plateau sections (fig. 3). Mississippian rock units include the Bedford Shale, Berea Sandstone, Sunbury Shale, and the very thick Cuyahoga Formation. The Bedford and Sunbury shales are weakly resistant rocks which tend to form valleys (fig. 3). The Berea Sandstone and the sandstones and siltstones of the Cuyahoga Formation are resistant to erosion; these units tend to form ledges or escarpments. Shale units within the Cuyahoga Formation tend to form valleys.

Natural exposures of Mississippian rocks are rare in Morrow County, and most of what is known about these rocks has been obtained from well records and quarries. Winchell (1874) mentioned that in the nineteenth century, nine quarries had been opened in the Berea Sandstone, and eight quarries had

been opened in the Cuyahoga sandstones. The Berea Sandstone was quarried along a line that stretched from Iberia in the north through Mt. Gilead to Fulton in the south. The large quarry one mile north of Fulton is now a lake. The Cuyahoga sandstone quarries were smaller and were located primarily in Troy and North Bloomfield townships in the northeastern part of the county. According to Hall and Alkire (1956) the major quarries at Mt. Gilead and Fulton were last active in 1918 or 1919.

## Drift Thickness

Early studies of the drift thickness of Morrow County were made by Winchell (1874) who estimated the thickness of drift to average 40 feet or less. Winchell (1874) envisioned that the bedrock surface of the county was nearly flat, and he believed the drift was thin except for the hilly drift in the eastern part of the county. From a study of water well records it is obvious that Winchell's estimate of 40 feet was much too low. The thickness of drift in Morrow County ranges from a few feet to over 300 feet (fig. 6) and the average drift thickness is 94 feet.

In general, the thinnest drift in the county, drift less than 50 feet thick, occurs in the Till Plain in Canaan, Cardington, Westfield, Lincoln, and Peru townships west of the Allegheny escarpment. The Allegheny escarpment impeded the movement of ice eastward, and thus a significant volume of till and related drift accumulated on the frontal slope of the escarpment. Drift in the lower part of the escarpment has a thickness of 50 to 100 feet, whereas near the top of the escarpment the drift thickness totals 100 or more feet. The drift thickness in the Allegheny Plateau in the eastern part of the county is primarily in the 50 to 200 feet range. The thickest drift is in South Bloomfield Township where most of the drift exceeds 200 feet in thickness, and much is thicker than 300 feet. Bennington, Harmony, Franklin, and Congress Townships also contain areas where the drift thickness exceeds 200 feet. In general, the

Drift thickness:



0 - 20 feet



20 - 50 feet



50 - 100 feet



100 - 200 feet



200 - 300 feet



> 300 feet

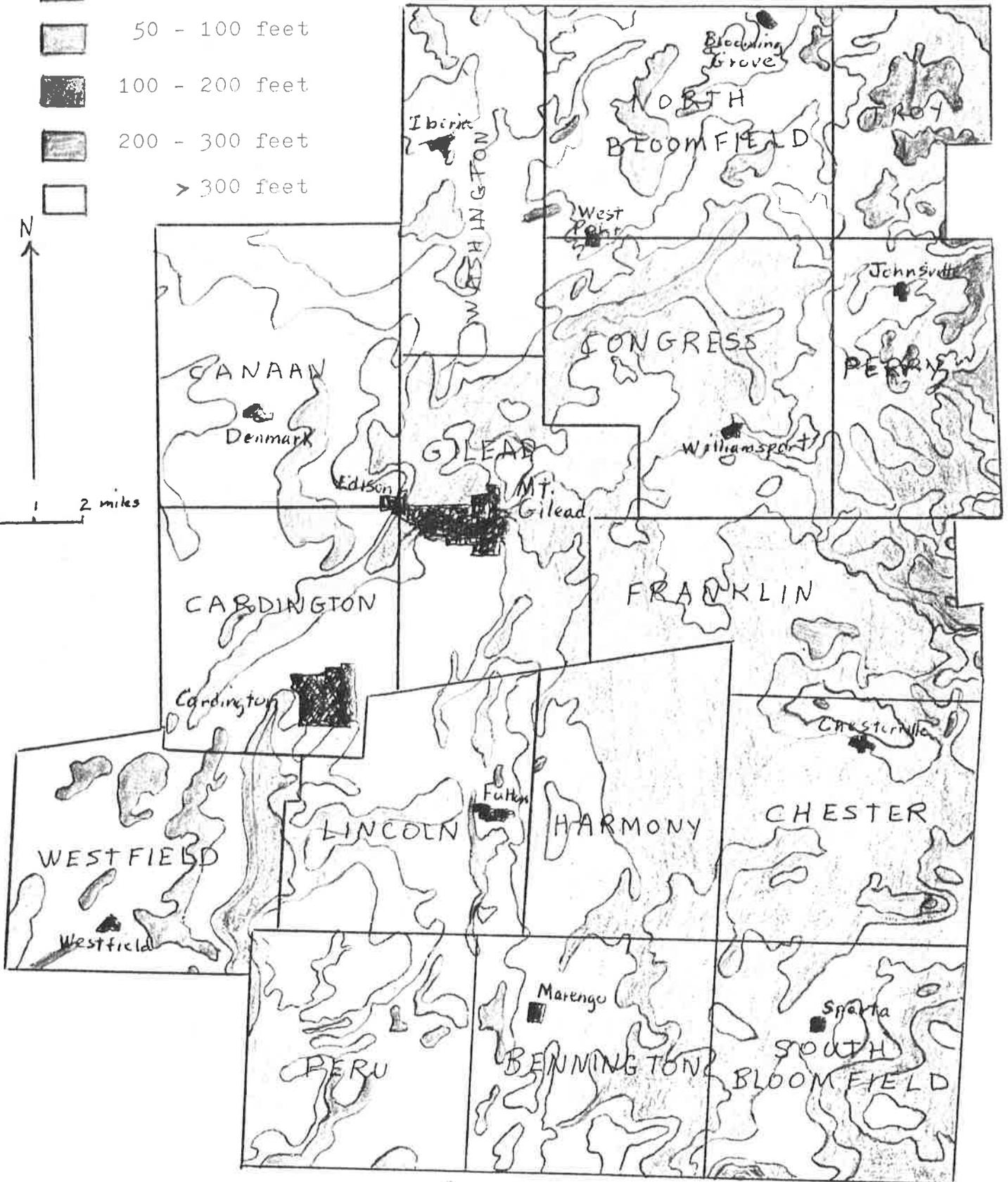
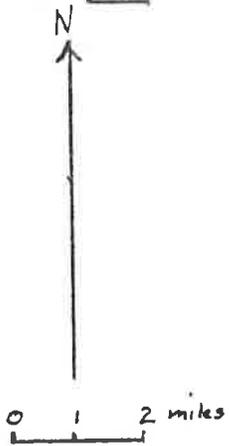


Figure 6. Drift thickness map of Morrow County  
(based on map prepared by Joel Vormelker)

areas containing the thickest drift mark the locations of buried valleys (fig. 5). The deepest buried valleys trend east-southeast in the eastern part of the county.

## Glacial Erosion

Glaciers moving eastward across Morrow County probably had only a minor effect on the preglacial bedrock topography. Morrow County is located near the glacial boundary; thus it is likely that the ice sheets had become much thinner when they reached the county and were in a depositional rather than erosional mode. The ice advanced parallel to several valleys in the plateau area, so it is possible these valleys were scoured by the thicker valley ice. Closed depressions marked by contours on the bedrock surface (Plate 1) may represent local ice scour, or they may represent areas lacking sufficient subsurface data for accurate mapping. Shale is most easily eroded by ice and it is reasonable to assume that the Ohio Shale in western Morrow County was eroded by ice to a depth of at least several feet. The absence of residual soil (paleosol) on the bedrock surface supports the view that at least minor erosion did occur. Jelloway or older till directly overlies the bedrock; during the last three or more ice advances into the county, the only material available for ice erosion would have been Jelloway <sup>or younger</sup> drift.

## TILL DEPOSITS

All of the glacial deposits at the surface and in shallow to deep cuts in Morrow County are of the Wisconsin Stage, the latest stage in glacial history (table 1 ). It is probable that pre-Wisconsin deposits occur deeply buried beneath Wisconsin deposits, primarily in buried valleys. Buried Pre-Wisconsin drift may also occur in favorable areas on the Allegheny escarpment (Low Plateau) and in the Allegheny Plateau, particularly in those places where drift thickness exceeds 100 feet. These older deposits are known only from drilling records.

Deposits of several advances of Wisconsin ice are sufficiently distinctive to be separated in the exposures where they may be seen. It is to be expected that, in any large exposure showing considerable thickness of glacial material, the glacial material will have been deposited by more than one ice advance and will differ more or less in character. The till deposited by each ice advance often is very thin. The last ice advance into Morrow County, ice that deposited the Centerburg Till, covered all except a small area at the extreme eastern edge of the county. Yet the Centerburg Till is thin or nonexistent at many places so that the uppermost recognizable till is not Centerburg, but the earlier MT. Liberty Till. At places where the MT. Liberty Till is very thin, even earlier till may be evident at or very close to the surface.

Table 1. Classification of glacial deposits in Morrow County

Epoch	Stage	Substage	Unit or interval	Material	Approximate dates (Years BP)		
Pleistocene	Wisconsinan	Woodfordian	Postglacial	Alluvium, loess, peat, lacustrine silt and clay	15,200		
			Late glacial				
			Centerburg Till	Dark brown clayey silty till		17,000	
			Mt. Liberty Till	Dark brown silty clayey till		19,500	
				Knox Lake Till	Yellow brown silty sandy till	23,000	
			Farm-dalian	Ice retreat (Flum Point Interstade)	Loess, stones, silt, sand, and gravel	33,000	
			Altonian	Jelloway Till (several units)	A	Olive brown, dark gray and dark gray brown hard stony till; sand and gravel lenses	40,000 (75,000?)
		B I					
		B II					
		B III					
B IV							
L							
	Pre-Wisconsinan		Lower units not exposed	Probable till, outwash, and alluvium in buried valleys and in areas of thick drift			

## Character and Composition of the Till

### General Statement

The various tills in north-central Ohio may be distinguished from one another by using several criteria including texture, composition, color, and weathering horizons. These characters are dealt with in more or less detail in several publications describing the glacial geology of Richland County (Totten, 1973), Wayne County (White, 1967), and Ashland County (White, 1977) to name just a few. In Morrow County, tills of the two latest ice advances (Centerburg and MT. Liberty) form the surface drift, but at some places where the later tills are thin or missing, an earlier till may be exposed at the surface. The thickest till is found in the belts of end moraine and the thinnest till occurs in the ground moraine areas of the Till Plain (Plate 1).

### Texture

Tills in north-central Ohio range from sandy, silty tills with relatively low clay content to clayey silty tills with a low sand content. The texture (grain size) of each till is reasonably constant. The tills at the surface in Morrow County are clayey or silty, but some relatively sandy till is found below these fine grained tills.

### Mineral Composition

Tills differ in content of quartz, feldspar, carbonate, and clay minerals. The carbonate content, including the calcite/dolomite ratios, has proven useful in identifying certain till units, particularly the Jelloway units. Mineral content of tills are included in Appendix A.

### Color

The color of till is a subtle but useful physical characteristic in till identification. At every thick till section two dominant colors may be seen: brown where oxidized at the surface and gray where unaltered at depth, the boundary between the colors commonly being 6 to 10 feet below the surface. The original gray color is due primarily to ferrous iron; oxidation to ferric iron gives the till a brown color, the shade of which is characteristic and relatively consistent. The oxidized tills at the surface of Morrow County are generally dark brown, tending toward chocolate brown, whereas the older subsurface tills have weathered yellow brown or olive brown. In the till descriptions, colors are recorded according to hue, value, and chroma as shown on a standard Munsell color chart.

### Weathering Horizons

Where the upper part of a till has not been removed by erosion or the work of man, tills can be divided vertically into five distinct horizons based on degree of weathering. In the weathering of till the first minerals to be attacked are the iron-bearing minerals, especially pyrite. These are oxidized, furnishing the brown color to the weathered till. Carbonates are leached, and the most resistant minerals, the silicates, are degraded.

Horizon 5 is the unaltered till in which the iron minerals have not been altered. On drillers' and engineers' records this horizon is sometimes called "blue clay with stones," but the color is some shade of gray rather than blue. Its top is usually 6 to 10 feet below the surface. In Morrow County gray till may be seen in the lower parts of deep highway cuts, in gravel pit excavations, and in the cliff sections along major streams.

Horizon 4 is calcareous till similar to that of Horizon 5 except it has been oxidized to a brown color. The top of horizon 4 is also the depth of leaching, which ranges from about 20 to 70 inches and averages **34** inches in Morrow County (fig. 7). In places carbonates leached from horizon 3 are reprecipitated along joints and partings in this horizon to form gray zones of secondary carbonate.

Horizon 3 is similar to horizon 4, except that in horizon 3 the carbonates have been leached. Iron oxide and manganese stains may be present along joints.

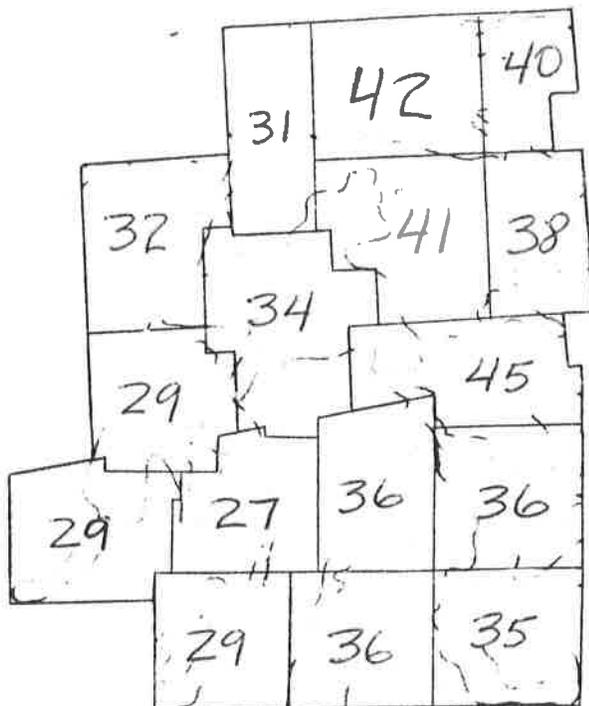


Figure 7. Average depth of leaching (by township)

Horizon 2 (essentially the B3 horizon of soil scientists) is the zone of decomposed till underlying the main part of the true soil. The horizon is not only oxidized and leached, but some of the pebbles and granules may have been decomposed. Some clay material has accumulated in the joints, and soil-forming processes are advanced. The material is not so completely weathered, however, that it cannot be identified as once having been till. The color of the upper part generally is a mixture of buff, gray, and brown. The lower part may have dark stains along the joints.

Horizon 1 is the soil, divided into the A and upper B soil horizons of pedologists. The characteristics of the soil differ with drainage and slope, as well as with parent material. The soils of Morrow County are dealt with in great detail in a report containing detailed soils maps (Gehring and others, in preparation) (fig 3).

Soil Associations

-  Centerburg - Bennington
-  Amanda - Centerburg
-  Blount - Pewamo
-  Glynwood - Blount
-  Rittman - Bennington
-  Rittman - Wooster
-  Shoals - Chili
-  Ockley - Lobdell

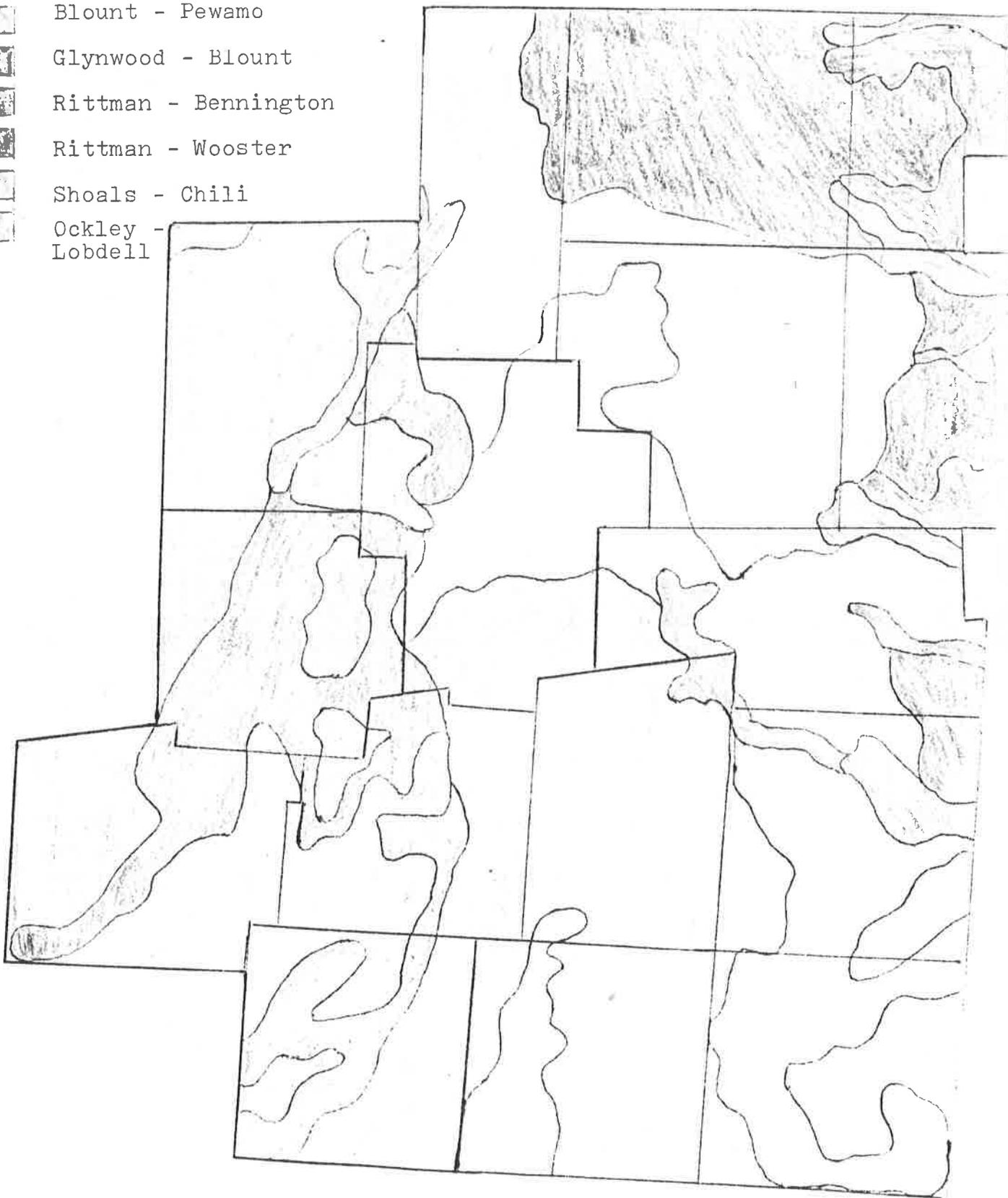


Figure 8. Generalized Soil Map of Morrow County, Ohio  
(advance copy provided by Richard Gehring, Soil  
Conservation Service)

## Jelloway Till

The Jelloway Till was named by Totten (1973) for the village of Jelloway in northeastern Knox County. This is the same till referred to as "Illinoian" in earlier glacial reports of north-central Ohio (White, 1937; Forsyth, 1961). Jelloway Till occurs in the subsurface beneath Centerburg, Mt. Liberty, and Knox Lake tills in Morrow County. On the average, the upper surface of the Jelloway Till occurs 7.5 feet below the ground surface. Because of its stratigraphic position beneath the younger tills, <sup>(fig. 10)</sup> the Jelloway Till is exposed primarily in lower parts of the deeper road cuts and in many stream cuts. Only the upper part of the Jelloway Till is exposed in most places in the county; the thickness and nature of the lower part of till largely is unknown.

Jelloway Till may be recognized by its very hard (firm) nature and its silty, pebbly, stony texture. The till is characterized by vertical joints that usually are faced with a rusty black or gray coating of iron and manganese oxides. The hard compact till may be broken with difficulty, and the till breaks around pebbles and stones in such a way to preserve perfectly the pebble shapes as molds.

Oxidized Jelloway Till typically is olive brown (2.5Y<sup>4/4</sup>.) in color; in a few places the color trends toward yellowish brown (10YR<sup>4/4</sup>) or grayish brown (2.5Y<sup>4/3</sup>). Unoxidized Jelloway Till typically is dark gray (10YR<sup>3/4</sup>-<sup>4/1</sup>) with some variation toward dark gray brown (10YR<sup>3/2</sup>). Unoxidized Jelloway Till usually occurs at depth of 8 to 9.5 feet in uneroded areas. Where

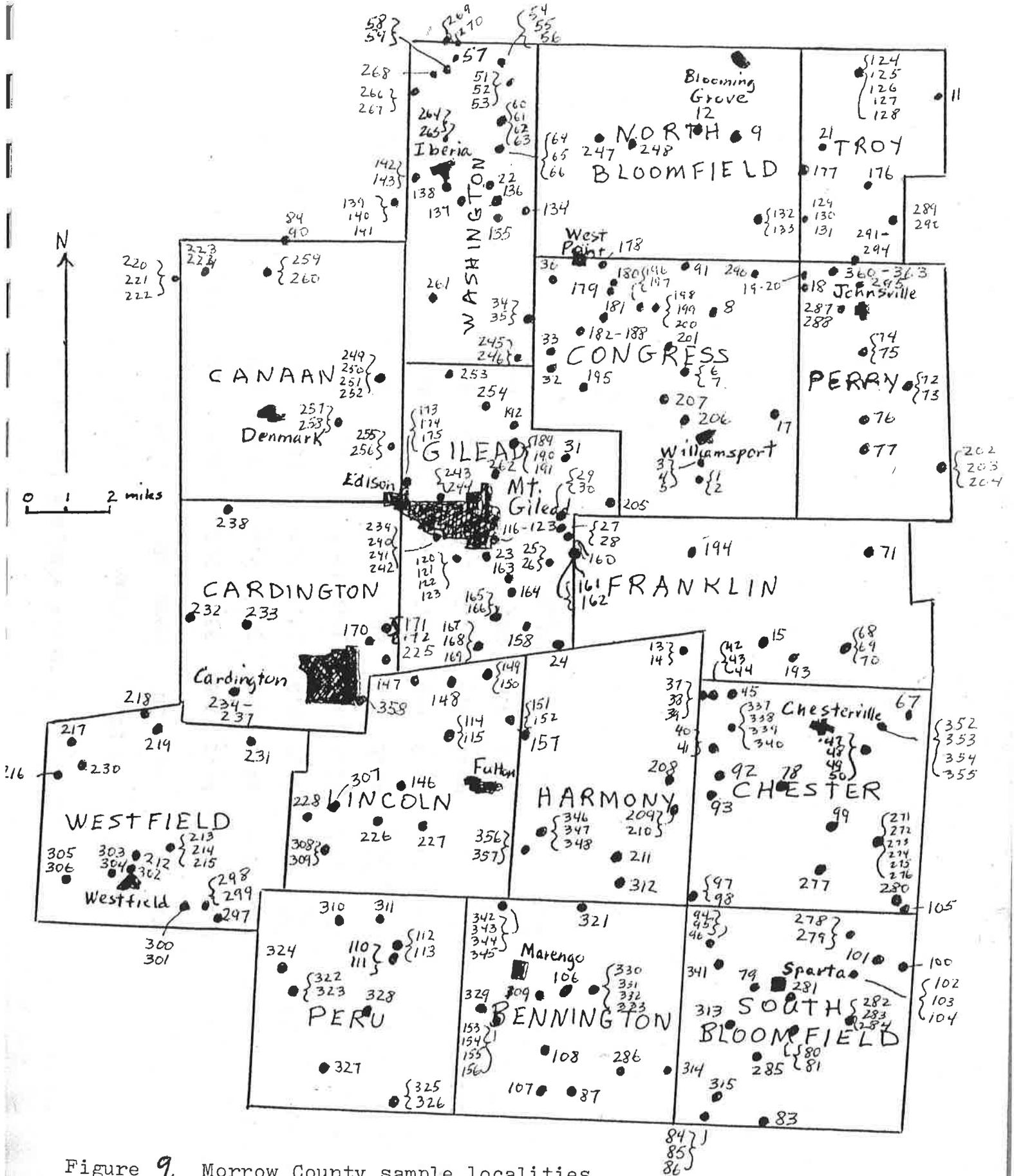


Figure 9. Morrow County sample localities

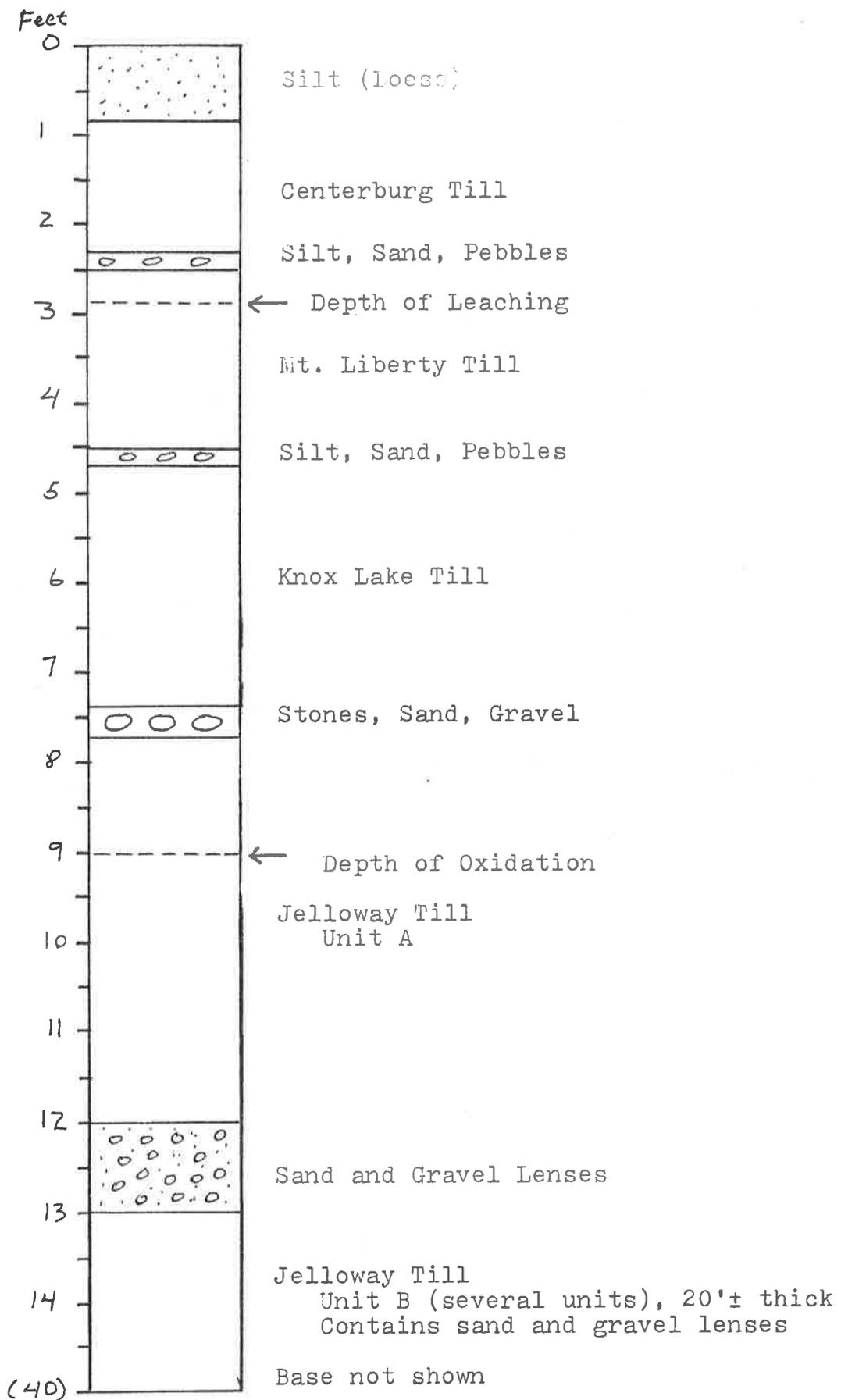


Figure 10. Profile showing average thicknesses of drift units in Morrow County

stream erosion has removed some surface material, unoxidized Jelloway Till may occur at depths of 6 to 8 feet.

The Jelloway Till in Morrow County is composed of six units, designated from top to bottom A, BI, BII, BIII, BIV, and L. All six Jelloway units have relatively similar textures (table 2, figure 11) of nearly equal amounts of sand and clay, with clay decreasing from BI to BIV and with sand predominating in BIV and L. The major basis for subdivision of Jelloway Till is carbonate content, including both total carbonate abundance and the calcite/dolomite ratio (fig. 12).

Most exposures of Jelloway Till show field evidence of two or more units separated by sand or gravel layers. The Jelloway units appear to be so similar physically, that only by carbonate analysis can they be separated from one another with certainty.

The lowermost Jelloway unit, Unit L, is represented by only one sample (156 in Bennington Township). This unit is characterized by relatively low dolomite and carbonate percentages, and a high (0.59) calcite/dolomite ratio (table 2). The distribution and thickness of this unit is unknown. Unit BIV is characterized by a moderate dolomite content which averages 9.2 percent and moderate calcite content averaging 2.1 percent. This unit is very stony and hard, yet small samples can be crumbled fairly easily between the fingers. The BIV unit occurs primarily in the eastern part of the county where it apparently makes up a major portion of the Johnstown moraine (primarily the "outer elements"). It also is present at depth in the Broadway moraine. Sand and gravel lenses frequently occur within the unit and in places also

Table 2. Statistical data of till sample analyses for Morrow County

Till Unit	No. of Samples	Sand		Silt		Clay		Calcite		Dolomite		Total Carbonate		$\frac{\text{Calcite}}{\text{Dolomite}}$	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Centerburg	17	18.5	4.7	48.1	7.6	33.4	7.8	2.5	2.0	7.0	4.3	9.5	5.9	0.36	
Mt. Liberty	83	23.8	2.9	44.0	6.7	32.2	7.0	3.2	0.7	7.9	3.9	11.1	5.3	0.41	
Knox Lake	122	28.2	4.6	44.2	7.2	27.6	7.3	1.9	2.1	7.6	4.1	9.5	5.5	0.25	
Jelloway	A	19	28.8	5.1	41.1	8.6	30.1	10.8	5.5	1.5	9.8	3.3	15.3	4.4	0.56
	B I	63	27.7	3.7	45.6	5.2	26.7	4.8	0.2	0.3	4.6	1.7	4.8	1.8	0.04
	B II	13	31.4	6.6	41.9	5.0	26.7	7.4	4.7	1.6	14.6	5.4	19.3	6.6	0.32
	B III	11	29.7	2.6	46.1	5.5	24.2	6.4	0.6	0.4	8.8	2.9	9.4	3.1	0.07
	B IV	17	32.0	4.5	47.7	3.6	20.3	6.5	2.1	1.1	9.2	4.4	11.3	4.9	0.21
L	1	30.8		44.3		24.9		2.9		4.9		7.8		0.59	

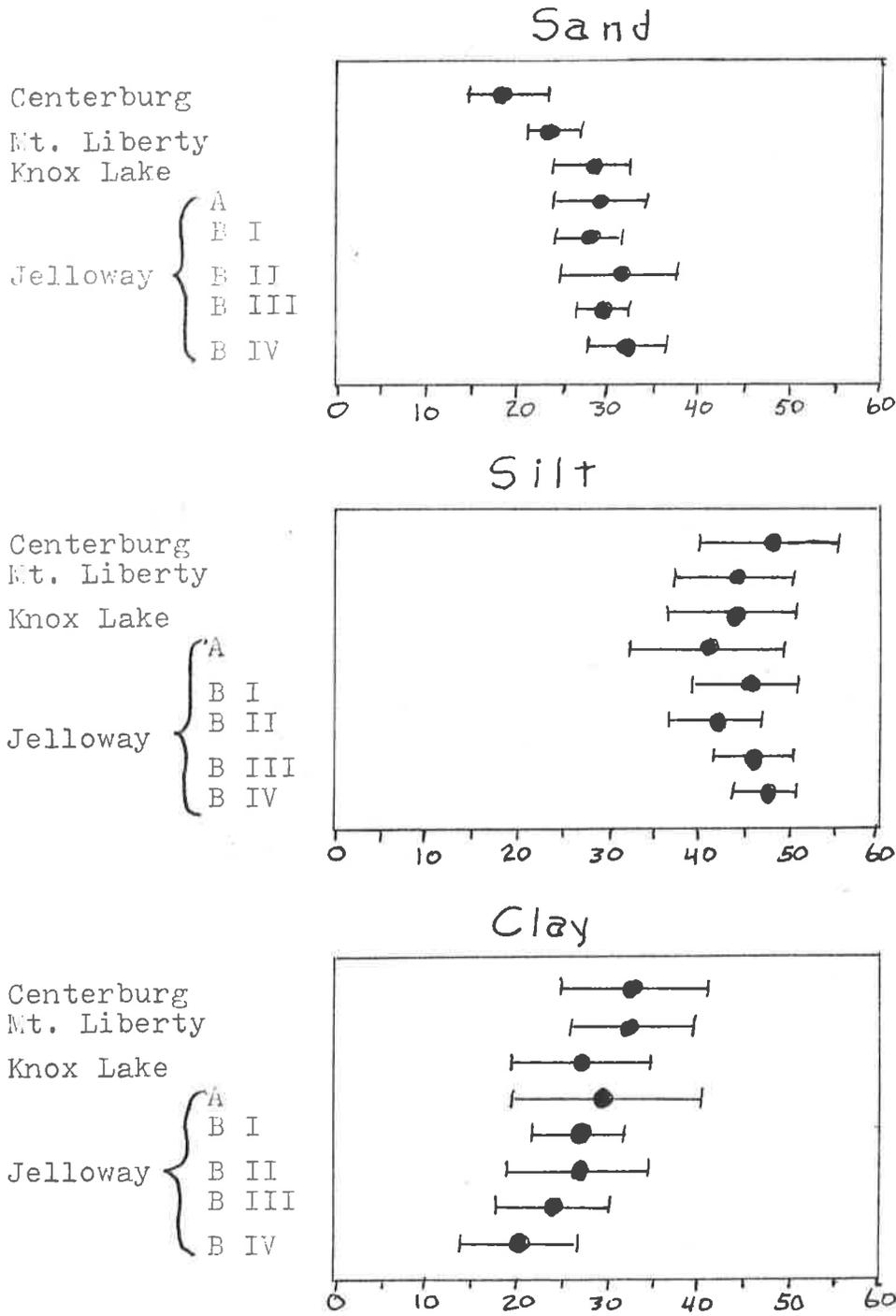


Figure II. Plot of means (solid circles) and standard deviations (solid lines) of sand, silt, and clay percentages of Morrow County till units.

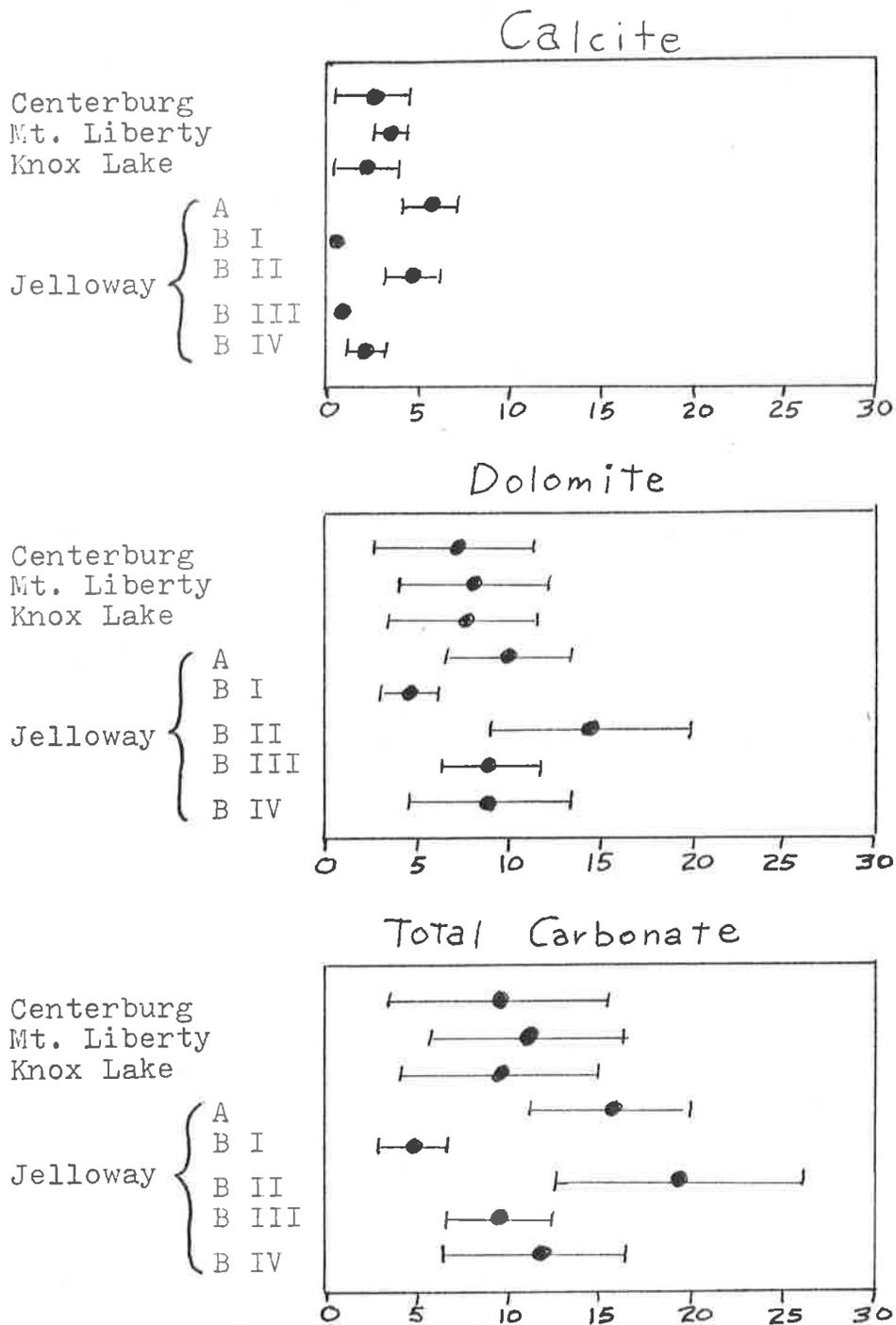


Figure 12. Plot of means (solid circles) and standard deviations (solid lines) of carbonate percentages of Morrow County till units

occur at the top of the unit.

Unit BIII is characterized by a low calcite content which averages 0.6 percent (table 2) and a moderate carbonate content which averages 9.4 percent. The calcite/dolomite ratio averages a very low 0.07. This unit was recorded from relatively few places primarily in the eastern part of the county where it occurs near the surface of the Johnstown moraine. It is absent in several sections where Unit IV is exposed. One of the best exposures of Unit III is in the streamcut near the Mt. Gilead Fairgrounds (section 117) where sand and gravel lenses occur both directly <sup>above and</sup> below the till.

Unit BII is characterized by a high calcite content averaging 4.7 percent and a very high dolomite content averaging 14.6 percent. Its average carbonate content of 19.3 percent is the highest by far of any till in the county. This unit is stony and hard on the outcrop, but small samples in places are easily crushed between the fingers similar to Unit IV. Unit BII occurs mostly near the surface in the eastern part of the county in the Johnstown moraine, and it occurs at depth beneath Unit BI in the Powell moraine in the central part of the county.

Unit BI is characterized by a virtual absence of calcite and a low dolomite content averaging 4.6 percent. It has an average carbonate content of 4.8 percent which is much lower than all other till units in the county. Unit BI is the thickest and most extensive of the Jelloway units exposed in Morrow County. This unit apparently makes up the bulk of the Powell and Broadway moraines in Morrow County, and it

occurs as a thin discontinuous veneer over much of the eastern part of the county.

Unit A is characterized by a high calcite content averaging 5.5 percent (table 2) and a high calcite/dolomite ratio of 0.56. Its carbonate content averages a high 15.3 percent. Unit A is most common in the western part of the county, and it appears to be discontinuous in the eastern part of the county. Its eastward limit is unknown, but apparently it extends at least as far as the eastern edge of the county. In counties to the north of Morrow County, Unit A apparently makes up the bulk of the Mississinewa, St. Johns, and Wabash moraines. The Mississinewa moraine in Morrow County may also be composed of unit A.

The Jelloway Till comprises the bulk of the till in the moraines in Morrow County and adjacent areas (Totten, 1969). The multiple units of Jelloway Till indicate a complex depositional history which probably includes both minor readvances during ice retreat, and thrusting of the ice near its outer margin. Units II, III, and IV most probably were deposited by a series of thrusts, advances, and retreats that formed the Johnstown moraine complex. Unit I probably was deposited in similar fashion to form the Powell and Broadway moraines.

The Jelloway Till and its correlatives are closely associated with thick, high quality gravel deposits in many places in north-central and northeastern Ohio (White, 1983, Totten, 1973). The thickest Jelloway gravels occur as kames, kame terraces, and valley trains in major buried valleys in the eastern part of the county. Thinner lenses of sand and

gravel occur within the Jelloway Till at many places in the county.

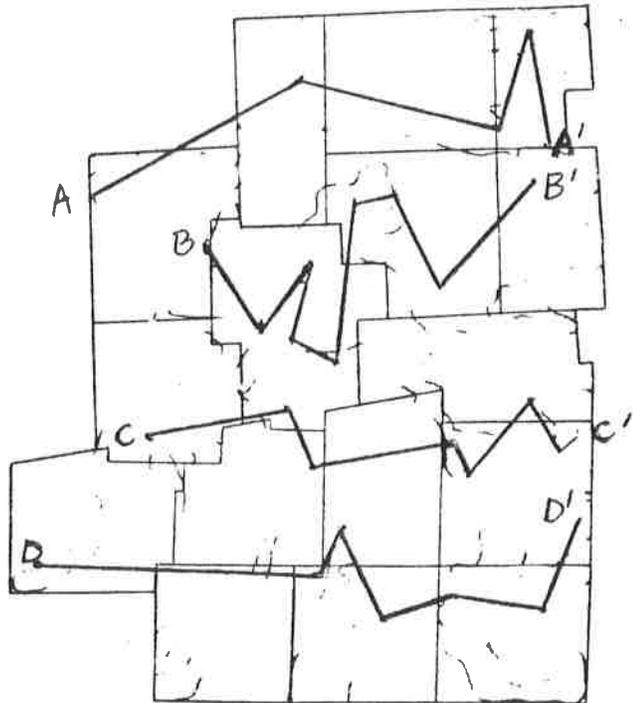
The Jelloway Till is correlative with the Millbrook Till of the Killbuck Lobe, the Mogodore Till of the Cuyahoga Lobe, and the Titusville Till of the Grand River Lobe (White, 1982). White, Totten, and Gross (1969) have assigned an Altonian (Early and/or Middle Wisconsinan) age for Titusville Till based on several radiocarbon dates of about 40,000 BP.

It is probable that pre-Jelloway drift occurs beneath the Jelloway Till in Morrow County in places where the drift thickness exceeds 100 feet (fig. 6). These older deposits, which probably include some interglacial deposits, especially in the buried valleys, are known only from well records.

Explanation

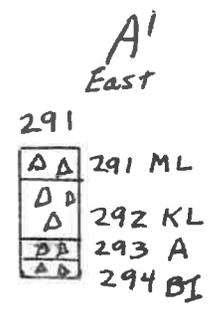
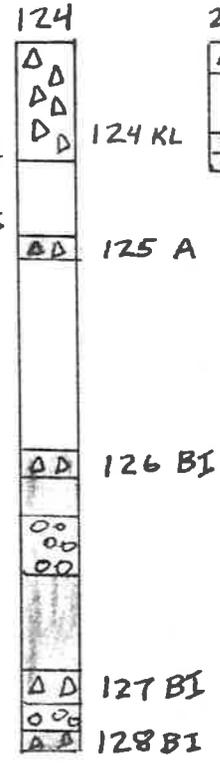
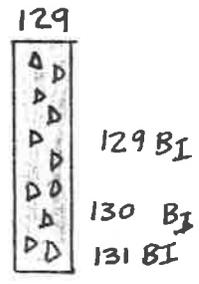
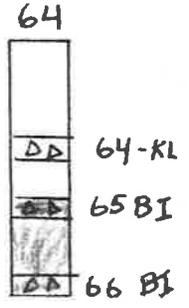
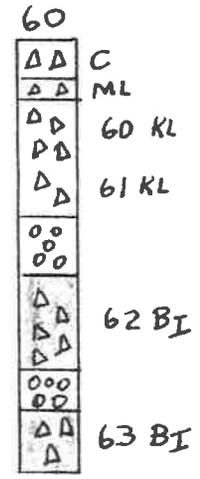
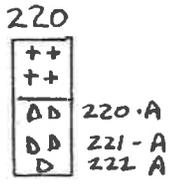
- C - Centerburg Till
- ML - Mt. Liberty Till
- KL - Knox Lake Till
- A - Jelloway Till Unit A
- B I - Jelloway Till Unit B I
- B II - Jelloway Till Unit B II
- D III - Jelloway Till Unit D III
- B IV - Jelloway Till Unit B IV

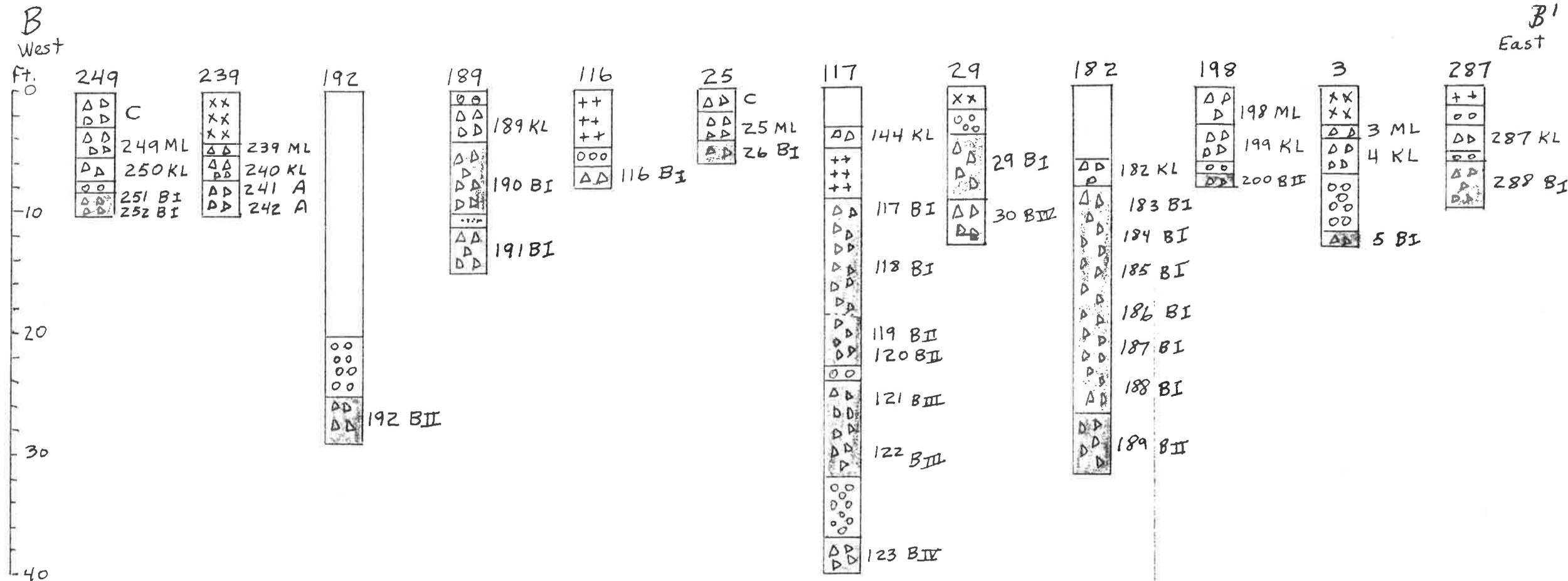
-  Covered
-  Disturbed
-  Silt
-  Till
-  Gravel
-  Sand



Location of cross-sections

Figure 13 Stratigraphic cross-sections of Morrow County

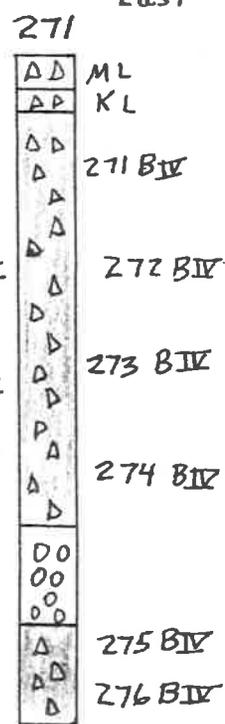
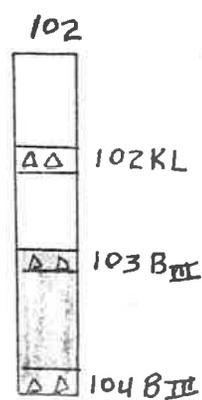
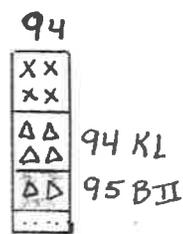
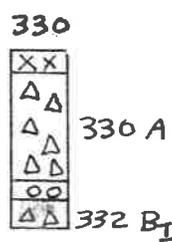
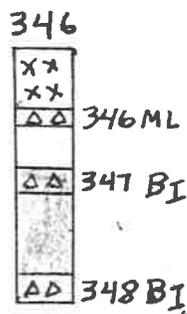
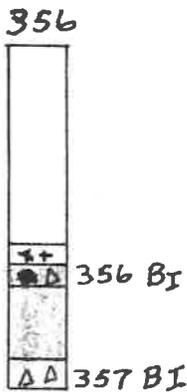
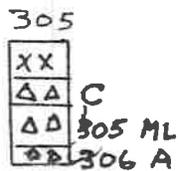




Section Z



D  
West



D'  
East

### Knox Lake Till

The Knox Lake Till was named by Forsyth (1961, p.126) for exposures near Knox Lake in northern Knox County. Although Forsyth applied the name Knox Lake both a soil and the till from which the soil developed, Totten (1973) applied the name specifically to till that correlated with the Navarre Till of the Killbuck Lobe.

Knox Lake Till is present in the subsurface at shallow depths in all parts of Morrow County. The thickness of Knox Lake Till commonly ranges from 2 to 6 feet and averages 33 inches in Morrow County. The Knox Lake Till is oxidized to a dark yellow brown (10 YR 4/4—5/6) in contrast to the olive brown Jelloway Till below and the chocolate brown tills above. The till is relatively silty and sandy, is loose, "mealy" (crumbly), and pebbly. Weathering of the till has produced closely spaced horizontal partings, and orange "spots" representing smeared soft iron-rich pebbles appear on freshly picked surfaces. Bare slopes exposed to sheet wash develop a stony and pebbly surface. Analyses of Knox Lake Till samples (Appendix B; table 2, fig. 14) indicate the till averages 28.2 percent sand, 44.2 percent silt, and 27.6 percent clay. Thus the Knox Lake Till has the highest sand content and the lowest clay content of the Woodfordian tills in Morrow County.

The depth of leaching of the Knox Lake Till is difficult to measure because younger material which overlies the till must also be leached. Leaching depths of 46 to 72 inches were



Figure 14. Distribution of sand percentages of Knox Lake Till (by township)

recorded in areas of mainly Knox Lake Till.

The major soil developed primarily in Knox Lake Till is the Wooster soil<sup>(fig. 2, Table 3)</sup> which has been mapped in a few places in eastern Morrow County. Wooster soils are well drained soils developed in low lime, pebbly, stony till and are characterized by a fragipan.

The contact between the MT. Liberty Till and the underlying Jelloway Till typically is marked by a stone line or a gravelly zone. Boulders up to 1 foot in diameter, and sand and gravel lenses as much as 5 feet thick occur along the contact. At MT. Gilead along the north valley wall of Whetstone Creek, the contact is marked by a layer of silt, interpreted as loess, 4 feet thick. This is the only place in the county where thick silt was observed along the contact. Perhaps a layer of loess formerly blanketed the Jelloway Till over much of the county but was later removed by the ice that deposited the Knox Lake Till.

Knox Lake Till samples average 1.9 percent calcite and 7.6 percent dolomite (ratio of .25). Knox Lake carbonate percentages show variation regionally in the county. Carbonate percentages are in the high 11 to 21 percent range in western Morrow County west of the escarpment<sup>(fig. 15)</sup>. The escarpment, which includes most of central and eastern Morrow County, is characterized by carbonates in the low 3 to 10 percent range. A small area in eastern Morrow County, including most of Franklin and Chester Townships, is characterized by carbonates in the high 9 to 23 percent range.

Table 3

## Relationship of Soil Associations to geology

<u>Soil Assoc.</u>	<u>General Characteristics</u>	<u>Dominant parent materials</u>
Blount-Pewamo	Nearly level Poorly drained	Centerburg Till Mt. Liberty Till
Glynwood-Blount	Gentle slopes Somewhat poorly drained	Centerburg Till Mt. Liberty Till
Centerburg-Bennington	Gently rolling Somewhat poorly drained	Thin Centerburg Till (absent in places) Mt. Liberty Till
Amanda-Centerburg	Moderate slopes Moderately well-drained	Centerburg Till thin or absent Mt. Liberty Till (low line)
Rittman-Bennington	Gently rolling Moderately well-drained	Thin Mt. Liberty Till (leached) Knox Lake Till
Rittman-Wooster	Moderate slopes Well drained	Very thin Mt. Liberty Till (absent in places) Knox Lake Till
Ockley-Lobdell	Level to gently sloping Well-drained	Recent alluvium Outwash sand and silt
Shoals-Chili	Level to gently sloping Well-drained	Outwash sand and gravel Recent alluvium

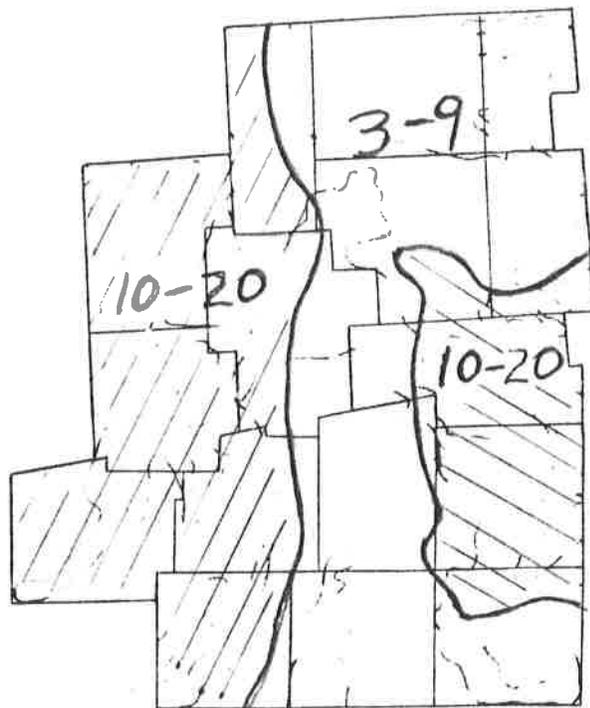


Figure 15. Distribution of carbonate percentages of Knox Lake Till

### MT. Liberty Till

The MT. Liberty Till, the second youngest till present in Morrow County, was named by Forsyth (1961, p.125) for the village of MT. Liberty in southwestern Knox County. Although Forsyth applied the name MT. Liberty to both a soil and the till from which the soil developed, Totten (1973) applied the name specifically to a brown till that correlated with the Hayesville Till of the Killbuck Lobe.

MT. Liberty Till is present in all parts of Morrow County, though it is present at the surface only along the eastern margin of the county. The thickness of MT. Liberty Till commonly ranges from 12 to 30 inches and averages 24 inches. The MT. Liberty is oxidized to a dark brown to dark yellow brown (10YR 4/3—4/4—5/4) with the dark brown or "chocolate" brown being most common. The till is predominately silty to silty clayey in texture, has a blocky to prismatic structure, and contains a small amount of pebbles and granules. Analyses of MT. Liberty Till samples (Appendix B; table 2, <sup>fig. 16</sup>) indicate the till averages 23.8 percent sand, 44.0 percent silt, and 32.2 percent clay. This composition places MT. Liberty Till intermediate between the Centerburg and Knox Lake textures.

MT. Liberty Till samples average 3.2 percent calcite and 7.9 percent dolomite (ratio of 0.41). The original carbonate content of the MT. Liberty Till may have been higher than recorded because of leaching of till samples collected from shallow depths. MT. Liberty carbonate percentages show a wide variation regionally



Figure 16. Distribution of sand percentages of Mt. Liberty Till (by township)

(fig. 17)

in the county. In Canaan, Cardington, and Westfield townships in the western part of the county, carbonate percentages are high, generally in the 13 to 23 percent range. The escarpment in North Bloomfield, Congress, eastern Gilead, Harmony, and Bennington townships have carbonate percentages in the low 4 to 11 percent range. In Perry, Chester, and South Bloomfield Townships along the eastern border of the county the carbonate percentages are in the high 13 to 19 percent range. One possible explanation for the low values on the escarpment is that MT. Liberty ice incorporated greater amounts of low carbonate material from the Knox Lake and Jelloway tills along its bed as it ground against the escarpment. Very possibly the MT. Liberty ice froze fast to its base along the escarpment, and faster moving ice may have sheared over the slowed outer margin, taking with it higher carbonate material which was deposited eastward of the escarpment.

The depth of leaching of MT. Liberty Till, recorded from places where the Centerburg Till is thin or absent, ranges from 30 to 48 inches and averages 37 inches. Weathered MT. Liberty Till in most places exhibits horizontal partings and when dry tends to break into small cubes. MT. Liberty Till provides at least part of the parent material for several different soils in the county. The Pewamo, Blount, and Glynwod soils usually have their lower part developed in this till. The Amanda, Centerburg, Bennington, and Rittman soils are derived, wholly or in part, from MT. Liberty Till. Amanda soils are well drained

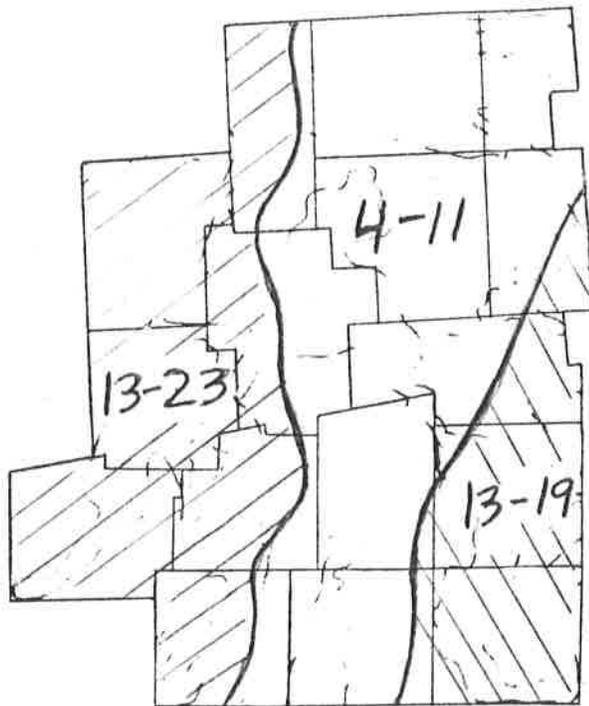


Figure 17. Distribution of carbonate percentages of Mt. Liberty Till

soils derived from low lime till that occurs mainly on end moraines. Centerburg soils are well drained soils derived from low lime till. Bennington soils are somewhat poorly drained soils derived from thin loess and low lime till. Rittman soils are moderately well drained soils derived from low lime till and are characterized by a fragipan—a compact zone in the B horizon that impedes root penetration and drainage.

The contact between the MT. Liberty Till and the underlying Knox Lake Till typically is marked by the presence of stones, boulders, gravel, sand, or silt. The silt, sand, and gravel occur as thin lenses 1 to several inches thick, and the zone is occasionally marked by small seeps or springs.

### Centerburg Till

The Centerburg Till, named for the village of Centerburg in southwestern Knox County by Forsyth (1961, p.123), is the youngest till in Morrow County. Although Forsyth applied the name Centerburg to both a soil and the till from which the soil developed, Totten (1973) applied the name specifically to a shallowly leached till that correlated with the Hiram Till of the Killbuck Lobe. The term Centerburg as used for a till is not to be confused with the Centerburg soil series as used in the recent soil survey of Morrow County. Centerburg Till may be considered to be the surface till over nearly all except the eastern border of the county (Plate 1) where MT. Liberty Till is at the surface.

The thickness of Centerburg Till ranges from 0 to 50 inches and averages 18 inches. Centerburg Till is about 2 feet thick along the west margin of the county, is present at nearly every exposure in the western half of the county, and it is discontinuous in the eastern part of the county. Its outer margin can be only generally determined by plotting the easternmost occurrences of Centerburg Till. It is possible that the till may be present farther east than noted on Plate 1. A till unit less than 1 foot thick at the surface is most difficult to positively identify because surficial weathering has significantly altered the till characteristics.

The Centerburg Till is oxidized to a dark brown (10YR4/3) often with a slightly different shade of dark brown from the underlying brown MT. Liberty Till. The difference in color between the Centerburg and MT. Liberty tills is so slight as to not be a reliable criterion for distinguishing between them. Centerburg Till is rich in clay and silt, has a prismatic to blocky structure, has a moderately high carbonate content where unleached, and is nearly devoid of pebbles and granules. The till contains such small amounts of coarse material that sometimes it is mistaken for lacustrine clay which it closely resembles.

The depth of leaching of carbonates primarily is dependent upon the thickness of Centerburg Till. In places where leaching has not progressed through the entire thickness of Centerburg Till, the leaching depth usually is between 22 and 28 inches, and averages 25 inches. In places where Centerburg Till is thin or absent, the depth of leaching may reach or exceed 50 inches and averages 34.3 inches in Morrow County. Weathering of Centerburg Till develops, in the subsoil, a fine prismatic structure.

Analyses of Centerburg Till samples (Appendix B; table 2) indicate the till averages 18.5 percent sand, 48.1 percent silt, and 33.4 percent clay. Thus the Centerburg has the lowest sand percentage, and the highest clay percentage of any till in Morrow County. Centerburg Till samples average 2.5 percent calcite and 7.0 percent dolomite (ratio of 0.36). It is likely that many of the Centerburg samples had experienced some leaching,

and thus the original carbonate content probably was higher, though not necessarily much higher than measured. The major soils developed in Centerburg Till are the Pewamo, Blount, and Glynwood soils. Pewamo soils are poorly drained soils developed in high lime till that occur on nearly flat areas. Glynwood soils are moderately drained soils developed in high lime tills that occur on end moraines and gentle slopes. Blount soils are somewhat poorly drained soils developed in high lime tills that occur in gently sloping areas.

Although the Centerburg is the youngest till in the county, late glacial and post glacial events were responsible for deposition of a wide variety of materials on top of the till in many places. Numerous shallow depressions existed on the till surface following deglaciation, and many are wholly or partially filled with lacustrine sediments such as clay, silt, and peat. Wind blown silt called loess forms a silt cap averaging 10 inches thick on top of the till in most places.

In some places the Centerburg Till rests directly on MT. Liberty with no material intervening between them. However, in most places, some material such as a few pebbles, stones, limestone fragments, or an inch or two of silt or sand occurs between the tills.

loess

At many places in Morrow County a silt cap occurs on the surface of the uppermost till. This silt, which comprises most if not all of the A horizon of the soil, is uniformly fine grained, is loose and friable, and is devoid or nearly devoid of pebbles and granules. Based on interpretations elsewhere in Ohio, this silt is thought to be loess, a wind blown deposit derived from the floodplains of glacial meltwater valleys located west of Morrow County.

The silt (loess) cap was recorded at 42 localities in all parts of the county. Measurements of loess thickness ranged from 6 to 18 inches, with an average thickness of 10 inches. Loess thinner than about 8 inches was difficult to recognize because very thin loess occurred wholly within the plow layer and was mixed with the underlying till. On steep slopes much of the loess probably has been removed by erosion.

The thickest loess was recorded from Congress and Perry townships in the northeastern part of the county where loess 14 to 18 inches thick was recorded in five localities. In Ohio the thicker loess deposits generally occur on older tills, which may be a plausible answer for the thicker Perry Township loess where the Centerburg Till is absent. However, the thicker loess in portions of Congress Township most likely is a result of local processes such as slope wash and ponding, with thick loess accumulating in shallow depressions on the landscape.

## GEOMORPHOLOGY OF THE GLACIAL DRIFT

The surface expression of the glacial drift in Morrow County has been produced by several ice advances and, during some of the retreats, by outwash deposits laid down upon, within, or beyond the melting ice. In addition to ice-related deposits, numerous small lakes existed for varying lengths of time after disappearance of the ice, and these lakes form distinctive features.

END MORAINES

General Statement

Four major end moraines can be traced from the south and southwest into Morrow County (fig. 18). From east to west in the county, these moraines are the Johnstown, Powell, Broadway, and Mississinewa. In Morrow County these moraines trend mainly north-south except in the eastern part of the county where the moraines make eastward loops in the major valleys. Each of the moraines is composed of more than one element (ridge); the Johnstown moraine is composed of 17 or more identifiable ridges (Plate 1)

Moraines were distinguished primarily on field recognition of hummocky topography. Morainic mapping was complicated by the fact that the major moraines predate the Woodfordian glaciation. These moraines have been overridden two or three times by ice, smoothed, and in places nearly "wiped out". An additional complication is provided by gravel kames which also have been overridden and are veneered with till of variable thickness which obscures<sup>e</sup> the gravel. Thus kames and moraines may have the same topographic appearance and both may have till-derived soils developed on them.

The end moraines of Morrow County were formed during the advance and retreat of two or more ice advances that deposited the Jelloway Till about 40,000-35,000 BP. Altonian ice advanced eastward into the county where it was slowed by the Allegheny escarpment. Consequently many of the moraines are bunched against the frontal slope of the escarpment. Ice that

advanced across and beyond the escarpment was thinner and advanced farther eastward in the valleys to form the intricate loops of the Johnstown moraine.

End Moraines

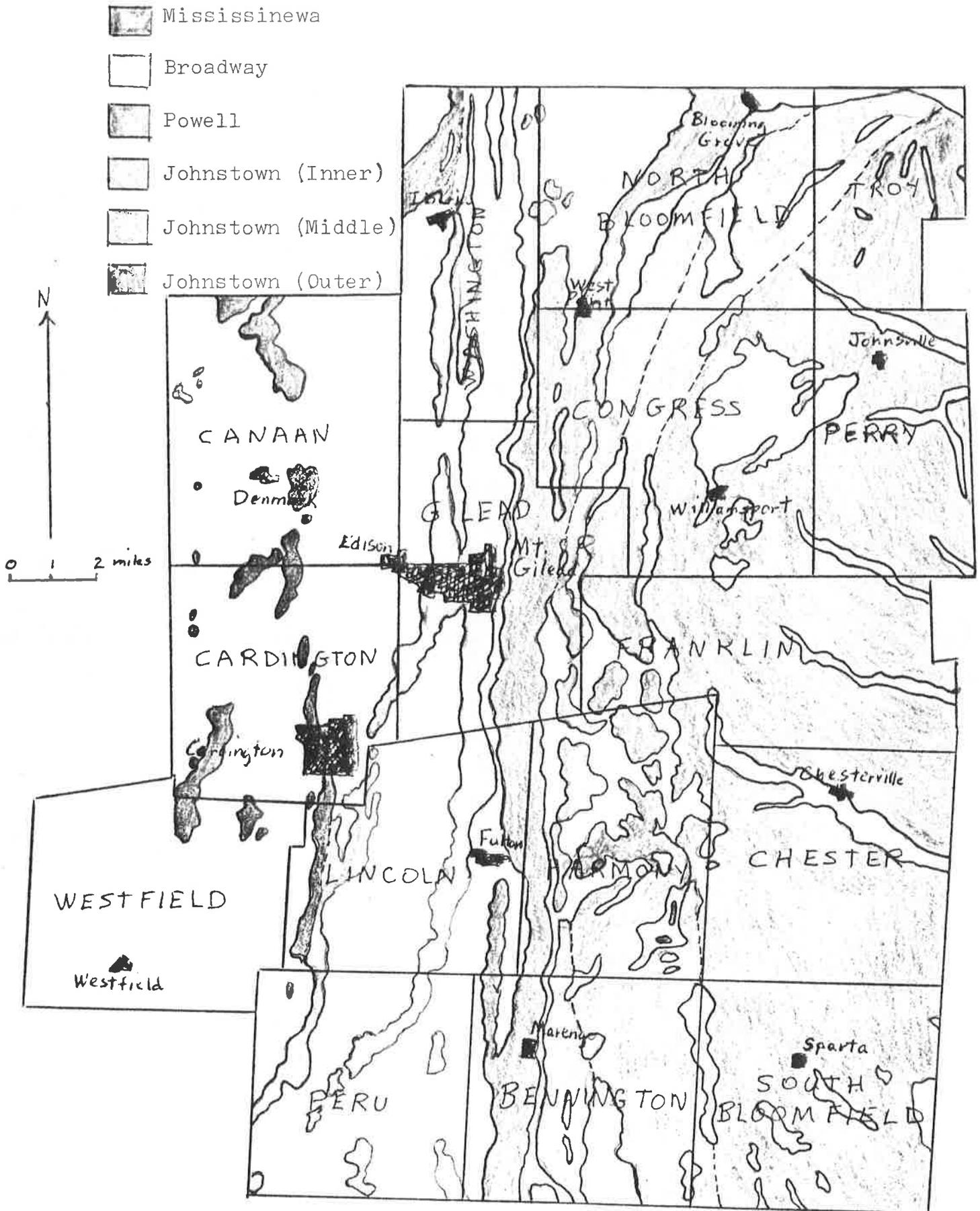


Figure 18. End moraines of Morrow County

### Johnstown Moraine

The most easterly and presumably the oldest moraine in Morrow County is the Johnstown moraine. Goldthwait and others (1961) were the first to assign a large tract of hummocky topography east of the Powell moraine in the eastern part of Morrow County and adjacent areas to the Johnstown moraine. The Johnstown moraine has been traced northward along the eastern margin of the Scioto lobe from central Fairfield County through Licking County into southwestern Knox County and eastern Morrow County (Goldthwait and others, 1961). Totten (1969) traced the Johnstown moraine from the Scioto lobe northward and eastward to the Killbuck lobe. Forsyth (1961, 1967) did not use the term Johnstown for the moraines in Knox County, but used several local names instead. In the southwestern part of the Scioto lobe the term Johnstown also is not used, and it is probable that the Cable, London, Bloomingburg, Marcy, and possibly one or two other moraines are equivalent to the Johnstown of Goldthwait and others (1961).

In Morrow County the Johnstown moraine consists of at least 17 elements or ridges that can be grouped into three belts (fig. 18) based on trend, development, and influence of local topography. The outer (eastern-most) belt consists of 9 closely grouped ridges which show pronounced loops into six east, southeastward trending valleys in Morrow County. The middle belt consists of 4 (or more) elements that are weakly developed and make small loops in the major valleys. The inner (western-most) belt consists of 4 (or more) poorly defined ridges that were only slightly affected by local topography.

The outer morainic belt occurs along the eastern border of Morrow County and extends an undetermined distance eastward into Richland and Knox counties. The elements are closely grouped, with 2 to 4 ridges occurring in the width of a mile, and 9 ridges occurring in the width of 5 miles.

Individual elements in the form of both ridges and hummocks rise 20 to 50 feet above their surroundings. The ridges have sinuous trends that were controlled by the local topography. The most pronounced loops of 1 to 4 miles in extent were made into the valleys of Clear Fork, North Branch Kokosing River, Kokosing River and Dry Creek. These ridges are easily traced on the uplands, but in many places their continuity is interrupted in the deepest part of the valley. In many places in or near the valleys the knolls are sharp and resemble kames, except they do not contain gravel.

The middle belt (fig. 18) is composed of 4 elements that have a combined width that ranges from 2 to 3 miles in width. This belt is discontinuous, particularly in Franklin and Harmony Township, and the ridges make relatively small loops of 1 to 2 miles into the major valleys.

The western (inner) belt is 1 to 2 miles wide (fig. 18) and is composed of 4 poorly defined ridges. The belt is oriented north-south except in North Bloomfield Township where the trend is northeastward as part of the loop<sub>A</sub> <sup>which extends</sup> into the large Clear Fork Valley. The inner (proximal) or western border of the Johnstown moraine is marked by a small tributary of Clear Fork in Troy and North Bloomfield Townships. South of Mt. Gilead the Johnstown moraine is separated from the

closely adjacent Powell moraine by a narrow trough-like depression which is occupied for  $8\frac{1}{2}$  miles by the southward flowing Big Walnut Creek.

Powell Moraine

The Powell moraine has been traced eastward and northward from its type locality in Delaware County into Morrow County by White (1935), who traced it as far north as Richland County. In Morrow County the Powell moraine extends 2 miles due northward from the southwestern corner of Bennington Township to West Point where it trends northeastward in North Bloomfield Township. The moraine is characterized by three crests or ridges which are fused into a single one mile wide belt in many places. The westernmost of the 3 crests is followed by State Highway 61 for 14 miles from Mt. Gilead southward to the Morrow-Delaware county line. The moraine is split into 2 elements for 4 miles between Marengo and Fulton, and is split for 7 miles northeast of Mt. Gilead. Both the eastern and western borders of the Powell moraine are distinct, and are typically marked by valley-like depressions. The eastern (outer) or distal margin is defined by the valley of Big Walnut Creek south of Mt. Gilead, and by the valleys of Sams Creek and tributaries of Whetstone Creek and Clear Fork northeast of Mt. Gilead. The western (inner) or proximal margin is separated from the nearby Broadway moraine by the valleys of Alum Creek and Whetstone Creek. The ridge crests are about 30 feet higher than the bordering valley bottoms. Low rounded knolls characteristic of the Powell moraine rise 10 to 25 feet above their surroundings.

### Broadway Moraine

The Broadway moraine has been traced from its type locality in Union County eastward into Delaware County and northeastward into Morrow County by White (1935). In Peru Township the Broadway moraine consists of two narrow low elements which are about 1 mile apart. In Lincoln Township the two elements diverge slightly, and then converge northward to Mt. Gilead where they are joined together. Each element is from 0.2 to 0.5 mile wide and consists of knolls and hummocks that rise 10 to 15 feet above the ground moraine. The eastern element is composed of two crests or ridges between Fulton and Mt. Gilead, and the double crested element continues northward for 13 miles from Mt. Gilead to Galion followed by State Highway 61. This double crested element averages about 1 mile in width and it rises about 30 feet above Whetstone Creek to the east. The hummocky knolls are intermediate in sharpness as compared with the sharper knolls of the Johnstown moraine and the low rounded knolls of the Mississinewa moraine. Three linear patches of hummocky topography situated between the Powell moraine and Alum Creek in Peru Township probably belong to the Broadway moraine. White (1935) mapped the ground moraine between the two Broadway elements in Peru and Lincoln Townships as part of the Broadway moraine based on slightly higher elevations. White's (1935) interpretation is not substantiated by field evidence although glacial erosion may have removed or smoothed portions of the ridge. The eastern margin of the Broadway moraine is defined in general by the valley of Alum Creek from the

the Delaware-Morrow county line northward to Mt. Gilead. North of Mt. Gilead the eastern border of the moraine is marked for 8 miles by the valley of Whetstone Creek, and for 2½ miles by small tributaries of Flat Run. The western margin of the moraine is not marked by a depression or valley.

Mississinewa Moraine

The Mississinewa moraine, which is well-developed in the Miami Lobe of western Ohio (Goldthwait, et al, 1961), was first traced into western Morrow County by Totten (1969) who utilized aerial photographs and profiles. This moraine is not shown on the state map (Goldthwait, et al, 1961).

The Mississinewa moraine consists mainly of small low hummocks that have a linear trend in Lincoln, Canaan, Cardington, Washington, and Westfield townships in western Morrow County. Three elements of the moraine can be recognized in the county; all three are discontinuous and are composed of "weak" hummocks 5 to 15 feet high. The eastern-most (outer) element of the Mississinewa moraine is in contact with the Broadway moraine north of Iberia in Washington Township and south of Cardington in Lincoln Township. Between Iberia and Cardington, the Mississinewa elements bend westward slightly and so extend across the eastern corner of Marion County. The outer element can be traced as a series of short ridge-like segments north from Cardington and Canaan townships. The middle and inner elements are less distinct and are represented by several knolls aligned in a north-south direction in the western part of Cardington and Canaan Townships.

### Ground Moraine

Slightly less than half of the surface of Morrow County consists of ground moraine (Plate 1). The ground moraine surface generally is a gently undulating plain which has undergone slight dissection by streams. In many places the surface may appear to be both flat and horizontal; however the ground moraine surface is composed mainly of gentle slopes. The surface till of the ground moraine is mainly Centerburg Till in which are developed the somewhat poorly drained Blount, Pewamo, and Glynwood soils. In places where the Centerburg Till is thin, the soils are developed in older tills which usually provide better drainage characteristics.

## Late Glacial and Post-Glacial Lakes

A large number of lakes were formed in Morrow County by the irregular deposition of glacial drift. Three major types of lake basins may be recognized: linear basins (troughs) between two parallel morainic ridges, irregularly shaped narrow valley segments dammed at one or both ends by morainic dams, and circular to irregularly shaped kettles formed during the melting of buried ice blocks. Many of the smaller kettles are associated with gravel of kame terraces and thus do not hold water for any length of time because of the gravel's high permeability.

The largest lakes in the county and also probably the shortest lived occupied depressions between morainic ridges. Two large lakes, one in Washington Township and the other in Gilead Township, formed in this manner. The Washington Township lake bed, about 3 miles long and 0.5 mile wide, occupied the area between the Powell and Broadway moraines. Merger of the moraines near the southeast corner of the township closed off the south end of the lake in the fashion of a dam. The lake bottom has the appearance of a broad, nearly level plain that is fairly well drained. Drainage is both northward and southward by tributaries of Flat Run and Whetstone Creek. The lake probably existed for a short time following both the Jelloway and Woodfordian ice advances. It is possible that Woodfordian till is interbedded

in the lake deposits. The limited exposures in the lake plain revealed clayey silt of probable lacustrine origin to be the surface material.

The Gilead Township lake bed, about 4 miles long and 0.5 mile wide in places, occupied the depression between the Johnstown and Powell moraines south of Mt. Gilead. These two moraines merge in the northwest corner of Harmony Township to form the dam that blocked the depression. The lake bed generally is flat with a few very low knolls, and the surface has a gentle southward slope of 3 or 4 feet per mile. The sluggish headwaters of Big Walnut Creek drain nearly the entire length of the depression. Clayey silt and silty clay of probable lacustrine origin are the major sediments comprising the surface materials. Some thin poorly sorted gravel associated with the lake silts and clays is an indication that the depression may also have served as an outwash channel. No doubt the lake has had a complex history which included two or more lake stages followed by drainage and some alluviation by sluggish drainage as is occurring at the present time.

Multitudes of irregular, somewhat elongate lake basins are characteristic of southeastern Morrow County covered by the Johnstown moraine (Plate 1). Some of these lake beds occupy small, short depressions between moraine elements, but most of these lake beds are in former valleys that were nearly buried in drift. On a map (Plate 1) they appear as chains of lakes having the same general orientation as the modern drainage. These

lakes technically are not kettle holes formed by melting ice blocks, although their origin in some cases was somewhat similar. Apparently most of the depressions originated during formation of the moraines by Jelloway ice.

Some of the lakes apparently were incorporated into the streams of the Farmdalian interstadial. During the Woodfordian glaciation stagnant ice occupied many of the valleys and depressions, and protected them from filling with drift. Some of the largest and deepest basins are in the Kokosing River valley and its tributaries in Chester Township. Peat, silt, clay, and muck are typical sediments that occur in these lake basins, and most of the basins have been so completely filled with sediment that they now are swamps rather than lakes.

Most of the oval or circular kettle holes that are common in eastern Morrow County are small and shallow. Few of these are lakes today and those developed in gravel never held much water. Most of the kettles were very small, a few acres or less, and nearly all have been filled with sediment and now are swamps. As with the larger depressions, sediment filling the kettles includes peat, muck, silt, and clay.

## Alluvial (Outwash) Deposits

### Introduction

Water from the melting ice sheets carried gravel, sand, silt, and clay away from the ice to greater or lesser distances. The deposits are sorted as to grain size, and generally the finer silt and clay are washed farthest downstream leaving sand and gravel nearest the source.

The outwash which was carried down the valleys that were free of ice was deposited as valley trains, which filled the valleys to a certain level. Later when sediment was no longer supplied by the melting ice, the streams began to erode and lower their channels below the valley train surface, leaving more or less extensive remnants as terraces along the valley sides.

In some places, water flowing from the ice deposited cones of material against the ice edge, or in holes or low places in or on the ice itself. When the ice disappeared, these became mounds called kames. As some of this material was deposited right at the ice edge, it incorporated masses of unsorted debris (till) in the sand and gravel, which in kames tend to be more poorly sorted and irregularly bedded than valley train deposits.

During deglaciation, ice remained in some valleys after the uplands were free of ice, and meltwaters flowed on, around, or beneath the valley ice. Most commonly, meltwater streams deposited sand and gravel between the tongue of ice in the valley and the valley sides. When the ice in the valley melted, the outwash remained along the valley sides as kame terraces. Smaller ice masses which were buried in the outwash eventually melted and the sand and gravel over them collapsed to form kettle holes, some of which are deep enough to extend below the water table, and thus are the sites of lakes or swamps.

During the latter part of the Pleistocene, the major drainage was to the east and south in Morrow County, and considerable amounts of sand and gravel were deposited in the larger valleys. The prominent end moraines deposited by Jelloway ice effectively blocked large segments of the eastward trending valleys, thereby creating a series of elongate valley lakes and swamps. Consequently, much outwash from melting of Wisconsin<sup>an</sup> ice was ponded, and finer grained silts and clays were deposited on top of coarser material in the ponded valleys. The stratigraphy in these buried valleys is extremely complex, and the surface material often is quite different in age and composition from the material encountered in the subsurface.

### South Bloomfield Township Kames

Four groups of small kames or kame complexes occur in South Bloomfield Township. The largest of these is located in the southwest corner of the township near the Knox-Morrow county line at the head of Sugar Creek. The kame complex measures 0.3 mi X 0.4 mi and is nearly 60 feet high. A gravel pit in the kame exposes about 25 feet of poorly sorted cobbly gravel. Slumped bedding characteristic of kames is evident and till masses are incorporated in the gravel. Mt. Liberty and Knox Lake Till overlie the gravel, and the Knox Lake till grades downward into kame gravel. Sample analyses of the till inclusions indicate the kame was formed by the same ice that deposited the Knox Lake Till. A second kame complex composed of three closely grouped kames occurs 0.7 miles northeast of Bloomfield. These kames are about 1000 feet in diameter and 20 to 30 feet high. Two small pits expose 15 feet of poorly sorted gravel. Several irregularly shaped kettles are adjacent to the kames. An irregularly shaped kame, 30 feet high and 2000 feet wide, occurs 0.5 miles southwest of Sparta. An exposure where state highway 656 cuts across the kame revealed rubbly gravel. A similar kame having the same dimensions occurs 1.5 miles northwest of Sparta. State Highway 229, which has cut across a section of the kame, has exposed poorly sorted sand and gravel. It is believed that all four of the kames or kame complexes belong to the Knox Lake ice advance, and the till cover is very thin.

### Sams Creek Kames

Six or more kames occur along the <sup>valley of</sup> Sams Creek and its tributaries in the partially buried channel of the ancient Kokosing River two miles east of Mt. Gilead. These kames occur mainly along valley sides and appear to be of limited extent. Gravel exposed in the kames is pebbly to sandy and is moderately well-sorted. About 5 feet of till overlies at least 20 feet of gravel which probably is Jelloway in age. The thick till covering tends to conceal the kames which may be more extensive than mapped (Plate 1).

### Washington Township Kames

A few small kames occur in Washington Township from Iberia north to the Morrow-Crawford county line (Plate 1). The three or more kames near the county line are small, and two have been exploited for gravel. One pit exposed 20 feet of gravel and sand in highly variable inclined beds. Till both overlies the gravel and grades laterally into gravel. The overlying till is Knox Lake, whereas Jelloway Till apparently is gradational with the gravel. The gravel in and near Iberia is poorly exposed and its extent or thickness is not well known.

### Canaan Township Kames

An area of gravelly soils having an extent of 1 square mile or more occurs southeast of Climax in northeastern Canaan Township. Auger borings in the area revealed silt, fine sand, and poorly sorted gravel, indicating the probable existance of

kames. The gravelly deposits occur in low knolls that rise barely 5 feet above the surrounding area. The occurrence of the gravel at or near the surface indicated the deposit is Woodfordian in age and is most likely associated with the Mt. Liberty ice advance.

#### Other Kames

Small isolated kames, usually associated with end moraines, occur at several places in Morrow County. The largest of these, and the only one associated with a gravel pit, is located in the Broadway moraine on the Washington—Gilead township line. The kame has a diameter of 0.25 mile, is 40 feet high, and is composed of poorly sorted gravel and sand lenses arranged in steeply dipping beds. Silt and till of probable Knox Lake age overlie the gravel, indicating the kame is probably Jelloway in age.

### Kokosing Valley Kame Terrace

The major kame terrace in Morrow County is located in the wide, partially buried Kokosing River valley in southern Franklin, northeastern Harmony, and northern Chester townships. The terrace has a total length of about 6 miles in the county, and it extends several miles eastward from the Morrow-Knox county line to Fredericktown in Knox County. In Morrow County the major terrace segments are located north of the channel of the Kokosing River.

An element of the Johnstown moraine plugged the Kokosing valley west of Chesterville, thereby dividing the terrace into two sections, an upper section northwest of Chesterville and a lower section southeast of Chesterville. The northwest section is about 3 miles long and is nearly 0.5 mile wide where it is crossed by Interstate 71. Low kame-like hummocky knolls about 10 feet high are characteristic of the terrace surface. Poorly sorted gravel was exposed in a large borrow pit a short distance southwest of the Interstate 71 - State Highway 95 interchange. Most of this gravel occurs beneath the water table and must be dredged if large quantities are to be excavated. The terrace segment southeast of Chesterville is about 3 miles long and as much as 0.4 mile wide. This terrace has a hummocky topography with a relief of 10 to 20 feet, and closed depressions are common on its surface. The most extensive and highest quality gravel in the county has been excavated from several pits in this terrace. At the southeast edge of Chesterville the gravel

is moderately coarse, moderately well sorted, and contains boulders up to 12 inches in diameter. Farther downstream 1.2 miles southeast of Chesterville the gravel is well sorted, cross-bedded, pebbly, and contains sand lenses. Good quality gravel extends to a depth of at least 60 feet in this terrace. The bedding and sorting indicate the gravel was deposited by a braided outwash channel that was probably cut mainly in stagnant ice which occupied the valley. Mt. Liberty and Knox Lake Till overlie the terrace gravels, a good indication that the terrace is Jelloway in age. Several small terrace remnants occur south of the Kokosing River near the Morrow-Knox county line. These segments, which are composed of sandy gravel, extend westward along a small unnamed tributary valley of the Kokosing.

#### North Branch Kokosing River Kame Terrace

A kame terrace extends for nearly 4 miles from the Morrow-Knox county line northwestward along the valley of North Branch in Franklin, Perry, and Congress townships. Terrace segments are well developed on both sides of the valley. The terrace segments have a maximum width of 0.2 mile and exhibit a hummocky topography consisting of knolls 10 to 20 feet high. Gravel is exposed in the upper terrace segments, and sand is exposed in the lower segments near the county line. The terrace has a relatively steep gradient of about 35 feet per square mile.

### South Branch Clear Fork Kame Terrace

Clear Fork of the Mohican River has been dammed in Richland County forming Clear Fork Reservoir which extends into extreme northeast Morrow County. Much of the kame terrace and other valley bottom sediments have been drowned by the reservoir, and only a narrow fringe of the terrace is above water level along the south valley wall. The terrace continues eastward along both valley walls of South Branch which empties into the reservoir at the Morrow-Richland county line. The main part of the terrace that occurs in Morrow County is about 3 miles long and is as much as 0.3 miles wide, though in most places it averages about 800 feet in width. Most of the terrace surface *is* characterized by knolls 10 to 20 feet high, and a few knolls rise 30 feet above their surroundings. Poorly sorted gravel was revealed in several small exposures in the kames. The terrace has a gradient of 6 feet per mile in Morrow County. A small terrace segment about 0.5 mile long at Blooming Grove apparently is a continuation westward of the South Branch terrace.

### Cedar Fork Kame Terrace

Cedar Fork kame terrace in Morrow County extends for nearly 5 miles along the valley of Cedar Fork in Perry and Troy townships, and it extends some distance eastward from Morrow County into Knox County. The extensive terrace on the north side of the valley is about 0.4 mile wide and has a hummocky surface with 10 to 20 feet of relief. The terrace on the south

side of the valley is about 0.2 mile wide and about 2 miles long. Gravelly sand 10 feet thick overlies till in the south wall of the terrace, whereas 15 feet of rubbly gravel is exposed in the north terrace segment. Jelloway till underlies the terrace gravel, and the terrace tentatively is assigned a Jelloway age.

#### Franklin Township Kame Terrace

A small kame terrace composed of short discontinuous segments occurs in an unnamed branch of Kokosing River in eastern Franklin Township southeast of Pulaskiville. Each of the several segments is 0.5 to 1 mile long, and 0.1 to 0.2 mile wide. The terrace surface exhibits low hummocks 5 to 10 feet high. The nature of the material in the terrace is unknown.

#### Flat Run Kame Terrace

A narrow kame terrace having low relief and a low gradient occurs along both sides of Flat Run in the northwestern corner of Canaan Township. The terrace along the north side of the valley is 1 mile long and 500 to 1000 feet wide; the terrace on the south side of the valley is 2 miles long and 500 feet to 0.3 mile wide. The slightly hummocky terrace surface has a relief of 5 to 10 feet and a gradient of 10 feet per mile to the southwest. Poorly sorted gravel is exposed in terrace segments on both sides of the valley. This terrace is unusual in that it slopes toward the southwest or toward the ice front rather than away from it. At the time the terrace was forming,

ice had retreated westward into Marion County and meltwater flowed southward in the Olentangy River which was an ice marginal stream.

*Kame*

North Fork Licking River, Terrace

A small kame terrace occurs in the very small valley of North Fork Licking River south of Bloomfield in South Bloomfield Township. Only a small 1.2 mile long segment of this terrace occurs in Morrow County; the terrace apparently continues some distance southward in Knox County. The terrace segments on both sides of the valley consist mainly of well developed kames 10 to 30 feet high and about 400 feet wide arranged in linear fashion. Poorly sorted gravel was exposed in this terrace which has been exploited for gravel in Knox County.

## MINERAL RESOURCES

### General Statement

The mineral resources of the glacial drift in Morrow County consist of sand and gravel and groundwater. These are discussed in detail below.

The resources of the bedrock do not form a part of this report, and only a brief summary is possible. In pioneer days, the many quarries in the Berea and Cuyahoga sandstones provided significant amounts of stone for the construction industry. These quarries have not been operated since 1919.

Petroleum production in Morrow County was negligible until 1961 when a well in Canaan Township struck oil in the Trempealeau Dolomite of Cambrian age at a depth of 2,900 feet (Adams, 1964). Adams (1964) reported that oil production in Morrow County by 1964 had reached 31,000 barrels per day from 146 producing wells. The boom of the 1960s is over, but moderate production and sporadic drilling has continued into the 1980s.

## SAND AND GRAVEL

### General Statement

Sand and gravel have been excavated from many pits in many parts of Morrow County since pioneer times. However, only one pit 1.2 miles southeast of Chesterville, operated by the Chesterville Sand and Gravel Company, is currently active on a commercial basis in the county. Several smaller "borrow" pits provide small quantities of bank run material "on demand" for local uses. From what is known, only one significant commercial sand and gravel deposit occurs in the county. This deposit is the segment of the Kokosing River kame terrace located between Chesterville and the Morrow-Knox county line.

### Chesterville Sand and Gravel Company pit

The largest sand and gravel pit in Morrow County is located in the Kokosing River kame terrace 1.2 miles southeast of Chesterville. Gravel exposed above the water table is gray, calcareous, pebbly to cobbly, well sorted, horizontally bedded, with cross-bedded sand lenses. About 25 feet of gravel is exposed above the water table, and 35 feet of gravel is dredged from below the water table, for a total commercial thickness of 60 feet. The gravel is overlain by till 2 to 12 feet thick, with the thinnest till occurring on the knolls, and the thickest till occurs in the depressions. MT. Liberty Till about 3 feet thick occurs at the surface, and it overlies the Knox Lake Till

which is about 5 feet thick. Large boulders occur in the Knox Lake Till, and these boulders are abundant in places. At one place in the pit, a layer of gray Jelloway Till about 2 feet thick occurs within the gravel sequence about 10 feet below the Knox Lake Till. A layer of gravel 3 feet thick immediately above the till has been cemented by calcium carbonate. This concrete-like layer must be discarded along with the till during the quarrying operation. The gravel contains large amounts of soft siltstone but otherwise is of good quality. The gravel is interpreted as being the deposit of a braided stream channel probably cut into stagnant ice. The surface of the gravel deposit is noticeably hummocky, and kettle-like depressions are common on the terrace. Topographically the deposit is definitely a kame terrace though the gravel does not show obvious inclined bedding typical of kames.

The kame terrace appears to continue along the north side of the Kokosing River for a mile northwest to Chesterville, and for a mile southeast to the Morrow-Knox county line. Gravel exposed in two abandoned pits at the southeast edge of Chesterville was similar to that exposed in the Chesterville Sand and Gravel Co. pit. The terrace extends for several miles northwest of Chesterville; However the gravel in the terrace is poorly sorted and less desirable for most uses.

Other Kame Terrace Gravel Deposits

In southwestern Peru Township near the Morrow-Delaware county line, 15 feet of coarse rubbly gravel is exposed along the Alum Creek valley wall. The gravel contains large amounts of soft shale and siltstone which impart a very poor quality to the deposit. Centerburg Till overlies the gravel deposit. The gravel is too coarse, and at too high an elevation, to be a valley train deposit. It is probably a kame terrace deposit of Knox Lake age.

### Kame Gravel Deposits

The kames in Morrow County generally are small, and they are few in number. Only about seven kames have been exploited for gravel, none of which is large enough to sustain a long range commercial operation. A pit in the kame astride the Washington-Gilead township line has exposed 15 feet of poorly sorted sand and gravel. Cobbles up to 3 inches in diameter are present and most of the gravel consists of relatively soft sedimentary rock materials. This Knox Lake till overlies the gravel which may be either Knox Lake or Jelloway in age.

Two miles east of the previously described pit in Congress Township, a kame in the Powell moraine near East Branch contains a pit in which 30 feet of poorly sorted gravel is exposed. Much soft sedimentary bedrock and masses of till are included in the gravel. The age of the gravel is uncertain: best guesses are Jelloway and Knox Lake.

A kame surrounded by outwash occurs on the grounds of the MT. Gilead fairgrounds. About 6 feet of till of two or more ice advances overlies rubbly poorly sorted gravel. Boulders up to 4 feet in diameter are included in the gravel which is Jelloway in age. Only 5 feet of gravel was exposed; much thicker gravel probably would be encountered in the center of the kame.

About 2 miles east of MT. Gilead, a small pit in a kame near Sams Creek exposed 20 feet of sandy, moderately well-sorted gravel. The surface was disturbed and no till was associated with the gravel that would aid in determining the age of the

deposit.

A pit in a kame south of the railroad tracks in Washington Township a short distance south of the Huron-Morrow county line exposed 20 feet of highly variable sand and gravel. Till overlies the gravel, and one pocket of thick Jelloway till is included in the gravel.

One mile south of Pulaskiville, a kame at the head of Sylvester Run is composed of very poorly sorted gravel. A small borrow pit in the kame exposed 8 feet of gravel overlain by MT. Liberty till. The kame is probably Knox Lake in age.

A pit in a South Bloomfield Township kame at the Knox-Morrow county line exposed 20 to 25 feet of highly variable poorly sorted gravel. MT. Liberty till overlies the gravel and masses of Knox Lake Till are included within the gravel. Many large cobbles are included in the deposit which exhibits steeply dipping beds characteristic of kames. Similar gravel is exposed in two pits in kames 1.5 miles northeast of the previous kame.

Alluvial Terrace (Valley Train) Deposits

Minor amounts of sand and gravel occur beneath portions of the terrace surfaces of several streams and rivers in Morrow County. Natural exposures of the alluvial deposits are rare, and the best indication of the nature of the materials is from the soils developed in them. One of the best exposures of terrace sediment is along the west valley wall of Whetstone Creek at Rivercliff Cemetery in MT. Gilead where 9 feet of sandy, loose, fine grained gravel is exposed.

### Whetstone Creek Alluvial Terrace

The most extensive alluvial terrace in Morrow County is located in the valley of Whetstone Creek which extends from Washington Township in the north to Westfield Township in the south, a distance of about 18 miles. The valley of Whetstone Creek is narrow and it follows a twisting irregular course. Consequently the terrace is preserved as a series widely scattered short segments, the longest of which is 1 mile in length and about 0.2 mile wide. The terrace segments have very gently sloping surfaces. The terrace slopes in a southerly direction, from an elevation of 1155 feet in the north to 945 feet in the south, for a gradient of about 12 feet per mile. Gravel pits which exploited the terrace gravels are old and overgrown. The best exposure of the terrace gravel is at River Cliff Cemetery at the east edge of MT. Gilead where loose sandy gravel 9 feet thick overlies gray shale. An excavation in the terrace south of MT. Gilead revealed 5 feet of sandy gravel overlying 9 feet of rubbly stony gravel.

### Alum Creek Alluvial Terrace

One of the most extensive alluvial terraces in Morrow County occurs in the valley of Alum Creek south of MT. Gilead. The terrace can be traced from the southeast corner of MT. Gilead almost due south a distance of 13 miles to the Morrow-Delaware county line. Near MT. Gilead the terrace is 0.25 mile wide and Alum Creek is little more than a ditch. Four miles south of MT. Gilead the valley becomes very narrow for a distance

of 2 miles and no terrace is present. South of Fulton the valley becomes wider, and terraces are well developed on one side of the valley or the other. In central Peru Township, terraces are preserved on both sides of the valley. Near West Liberty the valley reaches a maximum width of 0.4 mile. The terrace elevation is 1135' near MT. Gilead and 960' at the Morrow-Delaware county line, which is a gradient of about 13 feet per mile. Exposures are lacking in the terrace. Soils developed in the terrace indicate the material is silty and sandy.

#### Big Walnut Creek Alluvial Terrace

Several short terrace segments occur in Big Walnut Creek valley in western Bennington Township. The largest of the seven segments is 0.7 mile long and 0.1 mile wide. The valley is quite narrow and the segments occur only on one side of the valley at one place. The terrace surface is nearly flat and slopes southward from an elevation of 1130' north of Marengo to 1100' south of Marengo, for a gradient of about 8 feet per mile. The terrace sediment is inferred to be silty and sandy based on the soils developed in it.

Shaw Creek Alluvial Terrace

The Shaw Creek alluvial terrace is represented by numerous terrace segments along a 12 mile stretch of the valley in Canaan, Cardington, and Westfield Townships. Terrace segments are preserved only in a few places in the valley. A few extensive terrace segments occur in Canaan Township a short distance west of Denmark. A few additional segments occur in southwestern Cardington Township and northern Westfield Township. The terrace slopes from an elevation of 1020 feet near Denmark to 965' at Showtown, a gradient of about 5 feet per mile. No exposures occur in the terrace, but soils indicate the terrace material is silty and sandy.

## WATER SUPPLY

This report does not deal with water supply in any detail but some suggestions can be made. An earlier report by Stout, Ver Steeg, and Lamb (1943, pp.481—484) gives some information about water supplies of the villages in the county, and a map by Kostelnick (1981) summarizes more recent information. A great deal of more recent information is in the files of the Division of Water and the Division of the Geological Survey in Columbus.

Historically, most of the water used in Morrow County has come from wells completed both in bedrock and glacial drift, and this pattern is likely to continue in the future.

According to Kostelnick (1981), except for western Westfield Township, water supply from wells drilled into bedrock falls into two categories: very poor water possibilities (less than 2 gallons per minute) from Devonian shale in western Morrow County, and moderately good water possibilities (10 to 25 gallons per minute) from Berea and Cuyahoga sandstones. A small area in western Westfield Township is underlain by limestone at depths exceeding 200 feet. Wells drilled into limestone often produce water yields of 100 to 300 gallons or more per minute (Kostelnick, 1981).

Water supply from the glacial deposits is highly variable; generally yields suitable for at least minimal household needs can be obtained from wells completed in the drift in most parts

of the county. The highest yields from the drift, 100 to 300 gallons per minute, may be obtained from coarse sand and deposits in buried valleys in Congress, Gilead, and South Bloomfield townships (Kostelnick, 1981). Moderate yields of 25 to 100 gallons per minute are recorded from sand and gravel lenses in several buried valleys located in eastern Morrow County (fig. 5 ). The major sand and gravel aquifer is the buried Kokosing Valley and its tributaries in Chester Township.

Small amounts of ground water often may be obtained from sand and gravel lenses associated with till sheets. The thickest water-bearing sand and gravel lenses are associated with the Jelloway Till, and these gravelly lenses usually occur more than 20 feet below the ground surface. In the western part of the county underlain by Devonian shale bedrock, these gravel lenses at depths of 20 to 40 feet may offer the only hope for developing a ground of water supply. Kostelnick (1981) indicates large areas in western Morrow County where small supplies of groundwater (less than 10 gallons per minute) are most likely to be obtained from sand and gravel lenses. Similar gravel lenses also occur in the eastern part of the county, but are not as highly valued because more abundant water supplies are available from either extensive gravels in buried valleys or from the sandstone bedrock.

## ENVIRONMENTAL AND ENGINEERING GEOLOGY

General Statement

The environment is influenced in general by the major physiographic divisions (fig. 2 ) and in detail by the glacial and post-glacial forms and materials that comprise or mantle them. The glacial drift is an important factor in performance of engineering structures built upon or in the drift. The thickness, composition, and surface configuration of the drift must be considered. Of great importance for large structures or those involving deep excavation is the vertical variation in the drift, because at most places the till or tills below are of different composition, texture, and engineering properties. Gravel and sand may underlie the upper tills at depths ranging from a few feet to 50 feet or more, and be water bearing.

Engineering interpretations of the surface soils of Morrow County have been treated in the soil report by Gehring and others (in preparation). That report should be consulted for specific engineering test data and classification both in the Unified and in the AASHTO systems. The test data recorded in the soil survey pertain primarily to the upper 60 inches of the soil. The present geological report deals not only with the surface material, but is also concerned with the whole column of glacial deposits. These reports therefore are complimentary to each other. This geological report cannot provide sufficient detail for planning at a specific site, but they can point out features of the glacial stratigraphy that should be anticipated in detailed engineering in-

vestigations for a specific site.

The subsurface material becomes of increasingly greater importance as larger and larger structures and deeper and deeper excavations become more common. The parent material of soils over 90 percent of Morrow County is developed in the relatively clay-rich Centerburg and Mt. Liberty tills. The material beneath the Mt. Liberty is less clayey and therefore has more desirable engineering properties. In some projects, it may be desirable to strip off and discard the clayey till to take advantage of the more permeable material below. Also, the "interfaces" between till units often are water-bearing and this must be taken into account in excavations because water seeping causes piping and slumping.

#### Till Plain

The Till Plain represents a very gently rolling to nearly featureless surface in western Morrow County (fig. 2). This surface is dissected by a few small stream channels which provide fair to moderate drainage for the relatively clayey surface. The drainage of the area has been improved considerably since pioneer days by dredging and tiling so that the soil has high productivity. Homesites and other construction projects should be carefully planned to provide adequate drainage. Potential problems are wet basements and inoperative septic systems, particularly where homesites are closely spaced.

#### Low Plateau

The Low Plateau is a region of topographic contrasts which presents numerous potential environmental problems. The moraines

are fairly well drained, scenically interesting, and suited for a wide variety of uses. The numerous undrained depressions are swampy and unsuited for most uses unless they are artificially drained. Numerous streams, several of which are deeply entrenched through the moraines, offer opportunities for the construction of lakes. The very large Candlewood Lake development is an example of the innovative use of the natural resources in this area. Caution should be used in the installation of septic waste disposal systems as the relatively clayey till at the surface over most of this area is very slowly permeable and will accept effluent with difficulty.

#### Allegheny Plateau

The Allegheny Plateau of eastern Morrow County is an area of more or less rolling topography that is scenically interesting and is better drained than other parts of the county. The rolling hills coupled with the potential for lakes offer favorable conditions for homesites. Most of this area is covered with thin silty clayey till which presents relatively minor environmental problems. The steeper slopes, underlain by till, are susceptible to slumping and sliding if the slope angle is steepened or if vegetation is removed.

WASTE DISPOSAL  
Solid Waste

The safe and prudent disposal of solid waste is becoming more important as the population increases, as the amount of waste multiplies, and as environmental regulations become more detailed. Open burning and dumping have been illegal in Ohio since 1969 and the sanitary landfill method has become the standard method of disposing of solid waste. Landfills should be located in areas of Morrow County that have a thick till cover, have a low water table, have slight to gentle slope, and are not closely adjacent to urban centers. Areas where bedrock is closer than 25 feet of the surface should be avoided as should sand and gravel areas, valley bottoms, and steep hillsides. A comprehensive review of geologic considerations for selecting landfill sites is given by Groenewold (1974). The drift thickness map (fig. 6) is a most useful tool for preliminary selection of possible landfill sites in the county. Most of Morrow County is underlain by drift at least 25 feet thick, and most of the drift is till, especially beyond the confines of the buried valleys. The till, actually a stratigraphic sequence composed of several till sheets, is suitable for most types of landfill operation. Two problems that may be encountered are the possibility of a high water table and the presence of water-bearing gravel between till sheets. Groenewald (1974) states that the minimum amount of till or similar material between the solid waste and

the water table should be 5 to 30 feet depending on the circumstances, and he advises 25 feet for Ohio. If other conditions are suitable, the water table may be lowered and kept low by pumping ground water from wells or by constructing deep drainage ditches to a nearby valley. The drainage operation should be monitored carefully to ensure that effluent does not contaminate the water being drained from the area.

Morrow County has many areas that appear suitable for landfill sites due to the thicker than average till and the absence of gravel in most places. In 1984, the county landfill was located 2.5 miles south of MT. Gilead in the Broadway moraine. Materials excavated in the landfill operation included 17 inches of loess, 14 inches of Centerburg and MT. Liberty tills, 58 inches of Knox Lake Till, and 48 inches of Jelloway Till. The Jelloway Till is more compact than the other tills and is excavated with difficulty. Any future landfill in the county can be expected to have its lower part excavated in Jelloway Till. Besides the compact nature of the till, other potential problems include gravel lenses and joints in the till. Both the gravel lenses and the joints could permit effluent to percolate toward aquifers if they are not properly sealed with an impermeable barrier. A careful engineering study should be made before a proposed landfill site is selected.

## Septic Tanks And Tile Fields

The disposal of sewage effluent from septic tanks is a significant problem in many parts of the county that are not served by municipal sewers and sewage treatment plants. The geologic factors which affect the operation of septic tanks include permeability of the soil, depth to bedrock, depth to the water table, slope, and drainage. Limitations affecting proper disposal are listed by Gehring and others (in preparation) for each of the soil series for the county. In general, the soils over most of the county have severe limitations for septic tanks, mostly due to the low permeability of the Centerburg and MT. Liberty tills which form the surface materials. Many localities are characterized by a seasonably high water table, and tile fields may be flooded by rising water levels in wet seasons.

Possible areas acceptable for disposal of effluent are the sandy terraces and kames (Plate 1). Other places appearing suitable are the higher elevations in the eastern and northeastern part of the county where the Knox Lake Till is near the surface. The Wooster soil (fig. 8) is developed in Knox Lake Till. Drainage of effluent from septic tanks and tile fields may percolate downward through permeable Knox Lake Till and along joints in the underlying Jelloway Till until it reaches a shallow gravel aquifer in the Jelloway Till sequence. Shallow wells developed in the gravel lenses within the Jelloway sequence are

subject to bacterial pollution, particularly in areas where several septic tanks occur in a limited area.

## Recreation

Many recreational opportunities are provided by the natural and man-made features of Morrow County. Numerous additional opportunities for recreation abound in adjoining counties. Clear Fork Reservoir, a large man-made lake located mostly in Richland County, extends into the extreme northeastern corner of Morrow County where it is accessible from State Route 97. This reservoir provides recreational fishing, boating, swimming, and camping. Delaware Lake, a large man-made lake of the Olentangy River, is located in Delaware County a short distance southwest of Morrow County. The backwaters of this lake extend into Whetstone Creek in the southwestern corner of Westfield Township. This swampy backwater area is designated as part of the Delaware Reservoir Wildlife Area. Mt. Gilead State Park is a relatively small recreational area located in the valley of Sams Creek at the east edge of Mt. Gilead. Sams Creek is deeply entrenched through the Powell moraine in the park, and the two artificial lakes in the valley, known as Mt. Gilead Lakes, provide boating and a scenic background for hiking and picnicing. Candlewood Lake, an elongate "dendritic" artificial lake on Whetstone Creek is a private development in northwestern Congress Township. Homesites in the development spread over two square miles in this scenic rolling area. Other recreational lakes include Galion Reservoir in northern Washington Township, and many small private lakes, nearly all of which are man-made.

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APPENDIX A

Morrow County Till Samples

S <sup>ample</sup> N <sup>o.</sup> series	Till Depth Collected Inches	Till Unit	Brown B or Gray G	Depth of Leaching Inches	Section	County	Township	Quadrangle Map
1	45	ML	B	42	NW 34	Morrow	Congress	Shauck
2	54	KL	B	42	NW 34	Morrow	Congress	Shauck
3	42	ML	B	40	SE 27	Morrow	Congress	Shauck
4	66	KL	B	40	SE 27	Morrow	Congress	Shauck
5	150	JBI	G	40	SE 27	Morrow	Congress	Shauck
6	44	KL	B	39	NE 15	Morrow	Congress	Shauck
7	59	JBI	B	39	NE 15	Morrow	Congress	Shauck
9	45	ML	B	43	NW 23	Morrow	N. Bloomfield	Blooming Grove
11	60	KL	B	-	NE 16	Morrow	Troy	Blooming Grove
12	47	ML	B	44	SE 15	Morrow	N. Bloomfield	Blooming Grove
13	49	ML	B	47	4	Morrow	Harmony	Shauck
14	60	KL	B	47	4	Morrow	Harmony	Shauck
15	72	KL	B	-	-	Morrow	Franklin	Shauck
17	58	KL	B	-	SW 24	Morrow	Congress	Shauck
18	48	KL	B	-	NW 6	Morrow	Perry	Blooming Grove
19	32	ML	B	30	NE 1	Morrow	Congress	Blooming Grove
20	38	KL	B	30	NE 1	Morrow	Congress	Blooming Grove
21	44	JBI	B	42	NW 19	Morrow	Troy	Blooming Grove
22	72	JA	B	-	NW 25	Morrow	Washington	Galion
23	72	JBI	B	-	SE 2	Morrow	Gilead	Mt. Gilead
24	38	ML	B	34	NE 19	Morrow	Franklin	Mt. Gilead
25	39	ML	B	34	NW 7	Morrow	Gilead	Mt. Gilead
26	56	JBI	B	34	NW 7	Morrow	Gilead	Mt. Gilead
27	42	ML	B	36	NE 6	Morrow	Gilead	Mt. Gilead
28	84	JBI	B	36	NE 6	Morrow	Gilead	Mt. Gilead
29	96	JBI	B	60	NW 6	Morrow	Gilead	Mt. Gilead
30	132	J BIV	G	60	NW 6	Morrow	Gilead	Mt. Gilead
31	56	KL	B	54	SE 30	Morrow	Gilead	Mt. Gilead
32	56	KL	B	44	SE 18	Morrow	Congress	Mt. Gilead

Till Sample No. series	Depth Collected Inches	Till Unit	Brown B or Gray G	Depth of Leaching Inches	Section	County	Township	Quadrangle Map
34	52	KL	B	48	NE 12	Morrow	Washington	Mt. Gillead
35	66	J BI	B	48	NE 12	Morrow	Washington	Mt. Gillead
36	48	KL	B	-	SE 6	Morrow	Congress	Galion
37	60	J B II	B	-	-	Morrow	Chester	Chesterville
38	120	J B II	B-G	-	-	Morrow	Chester	Chesterville
39	180	J B IV	G	-	-	Morrow	Chester	Chesterville
40	36	-	B	30	-	Morrow	Chester	Chesterville
41	57	KL	B	30	-	Morrow	Chester	Chesterville
42	72	KL	B	-	-	Morrow	Chester	Chesterville
43	132	J B II	G	-	-	Morrow	Chester	Chesterville
44	192	J B III	G	-	-	Morrow	Chester	Chesterville
45	70	J A	B	-	-	Morrow	Chester	Chesterville
47	66	KL	B	36	-	Morrow	Chester	Chesterville
48	200	J A	G	36	-	Morrow	Chester	Chesterville
49	54	KL	B	42	-	Morrow	Chester	Chesterville
51	54	J BI	B	-	SW 12	Morrow	Washington	Galion
52	120	J BI	B	-	SW 12	Morrow	Washington	Galion
53	180	J BI	G	-	SW 12	Morrow	Washington	Galion
54	37	C	B	25	NE 11	Morrow	Washington	Galion
55	55	ML	B	25	NE 11	Morrow	Washington	Galion
56	72	ML	B	25	NE 11	Morrow	Washington	Galion
57	66	KL	B	-	NE 11	Morrow	Washington	Galion
58	120	KL	B	-	NW 11	Morrow	Washington	Galion
59	156	J BI	G	-	NW 11	Morrow	Washington	Galion
60	60	KL	B	48	SW 13	Morrow	Washington	Galion
61	108	KL	B	48	SW 13	Morrow	Washington	Galion
62	192	J B I	G	48	SW 13	Morrow	Washington	Galion
63	252	J BI	G	48	SW 13	Morrow	Washington	Galion

Till Sample M series	Depth Collected Inches	Till Unit	Blown B or Gray G	Depth of Leaching Feet	Section	County	Township	Quadrangle Map
64	60	KL	B	-	NE 23	Morrow	Washington	Galion
65	96	JBI	B	-	NE 23	Morrow	Washington	Galion
66	144	JBI	G	-	NE 23	Morrow	Washington	Galion
67	60	J BIII	B	48	-	Morrow	Chester	Centerville
68	66	KL	B	42	-	Morrow	Franklin	Shauck
69	76	J BI	B	42	-	Morrow	Franklin	Shauck
70	86	J BI	G	42	-	Morrow	Franklin	Shauck
71	252	J BI	G	-	SE 6	Morrow	Franklin	Shauck
72	41	ML	B	35	SW 16	Morrow	Perry	Shauck
73	49	KL	B	35	SW 16	Morrow	Perry	Shauck
74	42	KL	B	36	NE 18	Morrow	Perry	Shauck
75	140	J BI	B	36	NE 18	Morrow	Perry	Shauck
76	54	KL	B	44	SW 20	Morrow	Perry	Shauck
77	72	KL	B	-	NW 29	Morrow	Perry	Shauck
78	60	KL	B	36	-	Morrow	Chester	Chesterville
79	60	KL	B	-	NE 14	Morrow	S. Bloomfield	Chesterville
80	38	ML	B	32	SW 18	Morrow	S. Bloomfield	Chesterville
81	72	KL	B	32	SW 18	Morrow	S. Bloomfield	Chesterville
82	144	J BI	G	-	SE 23	Morrow	S. Bloomfield	Centerburg
83	38	KL	B	32	SE 24	Morrow	S. Bloomfield	Centerburg
84	44	KL	B	32	SE 25	Morrow	S. Bloomfield	Centerburg
85	240	KL	B	32	SE 25	Morrow	S. Bloomfield	Centerburg
86	44	ML	B	44	N 23	Morrow	Bennington	Olive Green
88	48	KL	B	44	N 23	Morrow	Bennington	Olive Green
89	29	C	B	23	-	Morrow	Canaan	Caledonia
90	60	ML	B	23	-	Morrow	Canaan	Caledonia
91	54	KL	B	-	SW 34	Morrow	N. Bloomfield	Bloomington
92	32	ML	B	-	-	Morrow	Chester	Chesterville
93	57	KL	B	-	-	Morrow	Chester	Chesterville

Till Simple M series	Depth Collected Inches	Till Unit	Brown or Gray G	Depth Leggings Inches	Section	County	Township	Quadrangle Map
94	60	KL	B	-	-	Morrow	S. Bloomfield	Chesterville
95	84	J	G	-	-	Morrow	S. Bloomfield	Chesterville
96	72	J B III	B	-	NC 6	Morrow	S. Bloomfield	Chesterville
97	40	ML	B	28	-	Morrow	Bennington	Chesterville
98	54	JA	B	28	-	Morrow	Bennington	Chesterville
99	54	J B II	B	42	-	Morrow	Chester	Chesterville
100	48	KL	B	32	NE 10	Morrow	S. Bloomfield	Chesterville
101	54	KL	B	-	NW 10	Morrow	S. Bloomfield	Chesterville
102	60	KL	B	-	SE 9	Morrow	S. Bloomfield	Chesterville
103	108	J B III	B	-	SE 9	Morrow	S. Bloomfield	Chesterville
104	180	J B III	G	-	SE 9	Morrow	S. Bloomfield	Chesterville
105	57	KL	B	-	NE 1	Morrow	S. Bloomfield	Chesterville
106	38	KL	B	32	-	Morrow	Bennington	Marengo
107	43	KL	B	42	-	Morrow	Bennington	Olive Green
108	50	KL	B	38	-	Morrow	<del>Bennington</del>	Marengo
109	42	KL	B	40	-	Morrow	Bennington	Marengo
110	34	ML	B	30	-	Morrow	Peru	Marengo
111	54	KL	B	30	-	Morrow	Peru	Marengo
112	36	ML	B	30	-	Morrow	Peru	Marengo
113	44	KL	B	30	-	Morrow	Peru	Marengo
114	22	C	B	20	-	Morrow	Lincoln	Marengo
115	30	ML	B	20	-	Morrow	Lincoln	Marengo
116	78	J B I	G	-	-	Morrow	Gilead	Mt. Gilead
117	108	J B I	G	-	-	Morrow	Gilead	Mt. Gilead
118	180	J B I	G	-	-	Morrow	Gilead	Mt. Gilead
119	252	J B II	G	-	-	Morrow	Gilead	Mt. Gilead
120	156	J B II	G	-	-	Morrow	Gilead	Mt. Gilead
121	180	J B III	G	-	-	Morrow	Gilead	Mt. Gilead
122	252	J B III	G	-	-	Morrow	Gilead	Mt. Gilead

Fill Sample M series	Depth Collected Inches	Fill Unit	Brown B or Gray G	Depth of Leaching Feet	Section	County	Township	Quadrangle Map
123	288	J B IV	G	-	-	Morrow	Gilead	Mt. Gilead
124	72	KL	B	-	NE 7	Morrow	Troy	Blooming Grove
125	120	J A	G	-	NE 7	Morrow	Troy	Blooming Grove
126	240	J BI	G	-	NE 7	Morrow	Troy	Blooming Grove
127	360	J BI	G	-	NE 7	Morrow	Troy	Blooming Grove
128	372	J BI	G	-	NE 7	Morrow	Troy	Blooming Grove
129	66	J BI	B	48	SW 30	Morrow	Troy	Blooming Grove
130	114	J BI	B	48	SW 30	Morrow	Troy	Blooming Grove
131	138	J BI	G	48	SW 30	Morrow	Troy	Blooming Grove
132	47	KL	B	33	SE 26	Morrow	N. Bloomfield	Blooming Grove
133	34	KL	B	31	SE 26	Morrow	N. Bloomfield	Blooming Grove
134	36	ML	B	24	SW 25	Morrow	Washington	Galion
135	30	ML	B	24	SW 25	Morrow	Washington	Galion
136	60	KL	B	-	SW 25	Morrow	Washington	Galion
137	40	ML	B	35	SE 26	Morrow	Washington	Galion
138	43	ML	B	31	NW 26	Morrow	Washington	Galion
139	48	ML	B	-	NE 35	Marion	Tully	Galion
140	102	JA	G	-	NE 35	Marion	Tully	Galion
141	126	-	G	-	NE 35	Marion	Tully	Galion
142	42	ML	B	-	NW 27	Morrow	Washington	Galion
143	120	J B II	G	-	NW 27	Morrow	Washington	Galion
144	60	KL	B	-	-	Morrow	Gilead	Mt. Gilead
145	96	Loess	B	-	-	Morrow	Gilead	Mt. Gilead
146	34	ML	B	30	-	Morrow	Lincoln	Marengo
147	24	C	B	21	-	Morrow	Lincoln	Marengo
148	35	KL	B	32	-	Morrow	Lincoln	Marengo
149	40	ML	B	26	-	Morrow	Lincoln	Marengo
150	51	KL	B	26	-	Morrow	Lincoln	Marengo

Till Simple M series	Depth Collected Inches	Till Unit	Blown B or Gray G	Depth of Leaching Feet	Section	County	Township	Quadrangle Map
151	52	KL	B	47	-	Morrow	Lincoln	Marengo
152	62	JBI	B	47	-	Morrow	Lincoln	Marengo
153	40	ML	B	-	-	Morrow	Bennington	Marengo
154	68	KL	B	-	-	Morrow	Bennington	Marengo
155	84	JBI	B	-	-	Morrow	Bennington	Marengo
156	208	JL	G	-	-	Morrow	Bennington	Marengo
157	52	KL	B	46	-	Morrow	Lincoln	Marengo
158	39	KL	B	36	-	Morrow	Gilead	Mt. Gilead
161	44	ML	B	32	SW 5	Morrow	Franklin	Mt. Gilead
162	62	KL	B	32	SW 5	Morrow	Franklin	Mt. Gilead
163	40	KL	B	-	NE 12	Morrow	Gilead	Mt. Gilead
164	32	ML	B	28	SE 12	Morrow	Gilead	Mt. Gilead
165	52	KL	B	28	NW 13	Morrow	Gilead	Mt. Gilead
166	63	JBI	B	28	NW 13	Morrow	Gilead	Mt. Gilead
167	79	KL	B	31	SE 14	Morrow	Gilead	Mt. Gilead
168	95	JA	B	31	SE 14	Morrow	Gilead	Mt. Gilead
169	125	JBI	G	31	SE 14	Morrow	Gilead	Mt. Gilead
170	32	ML	B	28	NE 23	Morrow	Cardington	Mt. Gilead
171	28	ML	B	22	SE 14	Morrow	Cardington	Mt. Gilead
172	37	KL	B	22	SE 14	Morrow	Cardington	Mt. Gilead
173	24	C	B	22	NW 34	Morrow	Cardington	Mt. Gilead
174	34	C	B	22	NW 34	Morrow	Cardington	Mt. Gilead
175	44	KL	B	22	NW 34	Morrow	Cardington	Mt. Gilead
176	60	KL	B	40	NW 29	Morrow	Troy	Blooming Grove
177	40	KL	B	30	SE 24	Morrow	N. Bloomfield	Blooming Grove
178	46	JBI	G	-	NE 5	Morrow	Congress	Galion
179	74	JBI	B	72	SE 5	Morrow	Congress	Galion
180	80	JBI	B	-	SE 5	Morrow	Congress	Galion
181	46	ML	B	42	NW 8	Morrow	Congress	Mt. Gilead

Till Sample No series	Depth Collected Inches	Till Unit	Brown or Gray G	Depth of Leaching Inches	Section	County	Township	Quadrangle Map
182	78	KL	B	-	SE 7	Morrow	Congress	Mt Gilead
183	114	KL	B	-	SE 7	Morrow	Congress	Mt. Gilead
184	156	JBI	G	-	SE 7	Morrow	Congress	Mt. Gilead
185	228	JBI	G	-	SE 7	Morrow	Congress	Mt. Gilead
186	278	JBI	G	-	SE 7	Morrow	Congress	Mt. Gilead
187	deep	JBI	G	-	SE 7	Morrow	Congress	Mt. Gilead
188	deep	JBI	G	-	SE 7	Morrow	Congress	Mt. Gilead
189	48	KL	B	-	NW 25	Morrow	Gilead	Mt. Gilead
190	72	JBI	G	-	NW 25	Morrow	Gilead	Mt. Gilead
191	140	JBI	G	-	NW 25	Morrow	Gilead	Mt. Gilead
192	250	JBI	G	-	SE 24	Morrow	Gilead	Mt. Gilead
193	50	KL	B	-	-	Morrow	Franklin	Shauk
194	60	KL	B	-	SE 3	Morrow	Franklin	Shauk
195	66	ML	B	-	SC 17	Morrow	Congress	Mt. Gilead
196	34	ML	B	32	NW 9	Morrow	Congress	Mt. Gilead
197	45	KL	B	32	NW 9	Morrow	Congress	Mt. Gilead
198	35	ML	B	34	NE 9	Morrow	Congress	Mt. Gilead
199	62	KL	B	34	NE 9	Morrow	Congress	Mt. Gilead
200	92	JBI	B	34	NE 9	Morrow	Congress	Mt. Gilead
201	42	KL	B	40	SW 10	Morrow	Congress	Shauk.
202	180	KL	G	-	SE 28	Morrow	Perry	Shauk
203	240	KL	G	-	SE 28	Morrow	Perry	Shauk
204	300	JBI	G	-	SE 28	Morrow	Perry	Shauk
205	70	JBI	B	-	SE 32	Morrow	Gilead	Mt. Gilead
206	38	KL	B	36	SC 22	Morrow	Congress	Shauk
207	54	KL	B	-	NW 22	Morrow	Congress	Shauk
208	37	ML	B	31	-	Morrow	Harmony	Chesterville
209	42	ML	B	30	-	Morrow	Harmony	Chesterville
210	72	KL	B	30	-	Morrow	Harmony	Chesterville

Till Simple M. series	Depth Collected Inches	Till Unit	Brown B or Gray G	Depth of Leggings Inches	Section	County	Township	Quadrangle Map
211	36	ML	B	30	-	Morrow	Harmony	Marengo
212	54	ML	B	-	SE 23	Morrow	Westfield	Ashley
213	40	C	B	28	-	Morrow	Westfield	Ashley
214	62	ML	B	28	-	Morrow	Westfield	Ashley
215	48	ML	B	28	-	Morrow	Westfield	Ashley
216	36	C	B	20	-	Morrow	Westfield	Waldo
217	37	ML	B	34	-	Morrow	Westfield	Waldo
218	60	JBI	G	-	-	Morrow	Westfield	Ashley
219	30	C	B	24	-	Morrow	Westfield	Ashley
220	48	J A	B	36	-	Marion	Claridon	Caledonia
221	60	J A	B	36	-	Marion	Claridon	Caledonia
222	66	J A	G	36	-	Marion	Claridon	Caledonia
223	28	C	B	24	-	Morrow	Canaan	Caledonia
224	35	ML	B	24	-	Morrow	Canaan	Caledonia
225	32	ML	B	29	SC 23	Morrow	Cardington	Mt. Gilead
226	28	C	B	25	-	Morrow	Lincoln	Marengo
227	27	ML	B	25	-	Morrow	Lincoln	Marengo
228	28	ML	B	24	-	Morrow	Lincoln	Ashley
229	26	ML	B	24	-	Delaware	Oxford	Ashley
230	32	ML	B	28	-	Morrow	Westfield	Ashley
231	49	KL	B	47	-	Morrow	Westfield	Ashley
232	33	ML	B	30	NW 18	Morrow	Cardington	Denmark
233	42	ML	B	36	SE 17	Morrow	Cardington	Denmark
234	84	JA	B	-	SW 29	Morrow	Cardington	Ashley
235	120	JA	G	-	SW 29	Morrow	Cardington	Ashley
236	216	JBI	G	-	SW 29	Morrow	Cardington	Ashley
237	240	JBI	G	-	SW 29	Morrow	Cardington	Ashley
238	26	ML	B	23	NW 5	Morrow	Cardington	Denmark

Till Simple M series	Depth Collected Inches	Till Unit	Brown B or Gray G	Depth of Leggings Inches	Section	County	Township	Quadrangle Map
239	60	ML	B	—	—	Morrow	Gilead	MT. Gilead
240	74	KL	B	—	—	Morrow	Gilead	MT. Gilead
241	98	J A	B	—	—	Morrow	Gilead	MT. Gilead
242	120	J A	G	—	—	Morrow	Gilead	MT. Gilead
243	48	KL	B	25	—	Morrow	Gilead	MT. Gilead
244	34	ML	B	28	—	Morrow	Gilead	MT. Gilead
245	30	ML	B	24	NC 13	Morrow	Washington	MT. Gilead
246	42	KL	B	24	NC 13	Morrow	Washington	MT. Gilead
247	51	KL	B	49	NW 20	Morrow	N. Bloomfield	Galion
248	50	KL	B	48	NE 20	Morrow	N. Bloomfield	Galion
249	44	ML	B	28	NE 23	Morrow	Canaan	MT. Gilead
250	72	KL	B	28	NE 23	Morrow	Canaan	MT. Gilead
251	98	J BI	B	28	NE 23	Morrow	Canaan	MT. Gilead
252	108	J BI	G	28	NE 23	Morrow	Canaan	MT. Gilead
254	36	ML	B	30	NE 23	Morrow	Gilead	MT. Gilead
255	38	ML	B	36	SE 26	Morrow	Gilead	MT. Gilead
256	41	KL	B	36	SE 26	Morrow	Gilead	MT. Gilead
257	37	ML	B	32	SE 22	Morrow	Canaan	Denmark
258	43	KL	B	32	SE 22	Morrow	Canaan	Denmark
259	38	ML	B	32	NE 5	Morrow	Canaan	Caledonia
260	50	KL	B	32	NE 5	Morrow	Canaan	Caledonia
261	34	KL	B	30	SE 3	Morrow	Washington	Galion
262	31	ML	B	24	NW 36	Morrow	Gilead	MT. Gilead
263	48	ML	B	—	SE 2	Morrow	Gilead	MT. Gilead
264	36	ML	B	24	NE 22	Morrow	Washington	Galion
265	54	KL	B	24	NE 22	Morrow	Washington	Galion
266	23	C	B	22	NW 15	Morrow	Washington	Galion
267	50	ML	B	22	NW 15	Morrow	Washington	Galion
268	22	C	B	20	SW 10	Morrow	Washington	Galion

Till Sample No series	Depth Collected Inches	Till Unit	Brown B or Gray G	Depth of Leggings Inches	Section	County	Township	Quadrangle Map
269	50	—	B	45	—	Crawford	Polk	Galion
270	33	ML	B	24	—	Crawford	Polk	Galion
271	60	J B IV	B	30	—	Morrow	Chester	Chesterville
272	96	J B IV	G	30	—	Morrow	Chester	Chesterville
273	168	J B IV	G	30	—	Morrow	Chester	Chesterville
274	240	J B IV	G	30	—	Morrow	Chester	Chesterville
275	360	J B IV	G	30	—	Morrow	Chester	Chesterville
276	408	J B IV	G	30	—	Morrow	Chester	Chesterville
277	54	KL	B	48	SW 2	Morrow	S. Bloomfield	Chesterville
278	51	KL	B	45	SW 2	Morrow	S. Bloomfield	Chesterville
279	66	J B III	B	—	NE 2	Morrow	S. Bloomfield	Chesterville
280	72	J B I	B	—	—	Morrow	Chester	Chesterville
281	66	KL	B	—	—	Morrow	S. Bloomfield	Chesterville
282	48	ML	B	—	—	Morrow	S. Bloomfield	Chesterville
283	58	KL	B	—	—	Morrow	S. Bloomfield	Chesterville
284	66	KL	B	—	—	Morrow	S. Bloomfield	Chesterville
285	48	KL	B	45	—	Morrow	S. Bloomfield	Centerburg
286	60	KL	B	48	SE 19	Morrow	Bennington	Olive Green
287	60	KL	B	37	SE 6	Morrow	Perry	Shauk
288	108	J B I	G	37	SE 6	Morrow	Perry	Shauk
289	42	ML	B	38	SE 29	Morrow	Troy	Blooming Green
290	48	KL	B	38	SE 29	Morrow	Troy	Blooming Green
291	14	KL	B	—	SE 31	Morrow	Troy	Blooming Green
292	44	KL	B	—	SE 31	Morrow	Troy	Blooming Green
293	52	J B I	B	—	SE 31	Morrow	Troy	Blooming Green
294	56	J B I	G	—	SE 31	Morrow	Troy	Blooming Green
295	60	KL	B	—	SE 6	Morrow	Perry	Blooming Green
296	39	KL	B	33	—	Morrow	Congress	Blooming Green
297	34	ML	B	32	—	Morrow	Westfield	Ashley

Till Sample M series	Depth Collected Inches	Till Unit	Brown B or Gray G	Depth of Leaching Inches	Section	County	Township	Quadrangle Map
298	34	ML	B	22	—	Morrow	Westfield	Ashley
299	52	KL	B	22	—	Morrow	Westfield	Ashley
300	27	ML	B	24	—	Morrow	Westfield	Ashley
301	35	KL	B	24	—	Morrow	Westfield	Ashley
302	48	ML	B	—	—	Morrow	Westfield	Ashley
303	36	ML	B	—	—	Morrow	Westfield	Ashley
304	60	KL	B	—	—	Morrow	Westfield	Ashley
305	36	ML	B	—	—	Morrow	Westfield	Waldo
306	54	J A.	B	—	—	Morrow	Westfield	Waldo
307	29	C	B	28	—	Morrow	Lincoln	Ashley
308	26	ML	B	—	NE 24	Morrow	Lincoln	Ashley
309	34	KL	B	—	NE 24	Morrow	Lincoln	Ashley
310	36	ML	B	30	SE 4	Morrow	Peru	Ashley
311	31	C	B	30	—	Morrow	Peru	Marengo
312	66	JA	B	—	—	Morrow	Harmony	Marengo
313	108	KL	B	—	SW 14	Morrow	S. Bloomfield	Chesterville
314	60	KL	B	38	SE 20	Morrow	Bennington	Centerburg
315	48	J A	B	—	SE 25	Morrow*	S. Bloomfield	Centerburg
316	26	ML	B	32	—	Knox	Hilliard	Centerburg
317	38	KL	B	32	—	Knox	Hilliard	Centerburg
318	19	C	B	27	—	Knox	Hilliard	Centerburg
319	30	KL	B	27	—	Knox	Hilliard	Centerburg
320	57	KL	B	45	—	Knox	Hilliard	Centerburg
321	54	KL	B	—	—	Morrow	Bennington	Marengo
322	40	ML	B	28	SW 18	Morrow	Peru	Ashley
323	54	KL	B	28	SW 18	Morrow	Peru	Ashley
324	30	ML	B	24	E 15	Morrow	Peru	Ashley
325	72	ML	B	—	—	Morrow	Peru	Olive Green
326	84	JB <sup>III</sup>	G	—	—	Morrow	Peru	Olive Green

Till Sample M series	Depth Collected Inches	Till Unit	Brown B or Gray G	Depth of Leggings Inches	Section	County	Township	Quadrangle Map
327	42	C	B	-	-	Morrow	Peru	Kilbourne
328	48	KL	B	-	-	Morrow	Peru	Ashley
329	48	ML	B	-	-	Morrow	Bennington	Marengo
330	48	J A	B	-	-	Morrow	Bennington	Marengo
331	66	J A	G	-	-	Morrow	Bennington	Marengo
332	84	JBI	G	-	-	Morrow	Bennington	Marengo
333	36	KL	B	34	-	Morrow	Bennington	Marengo
337	54	KL	B	-	-	Morrow	Chester	Chesterville
338	72	KL	B	-	-	Morrow	Chester	Chesterville
339	86	JBI	B	-	-	Morrow	Chester	Chesterville
340	Deep	JBI	B	-	-	Morrow	Chester	Chesterville
341	27	KL	B	24	-	Morrow	S. Bloomfield	Chesterville
342	24	ML	B	21	-	Morrow	Bennington	Marengo
343	33	JBI	B	21	-	Morrow	Bennington	Marengo
344	47	JBI	B	22	-	Morrow	Bennington	Marengo
345	96	JBI	G	-	-	Morrow	Bennington	Marengo
346	33	ML	B	30	-	Morrow	Harmony	Marengo
347	69	J BI	G	30	-	Morrow	Harmony	Marengo
348	132	J. BI	G	30	-	Morrow	Harmony	Marengo
349	96	KL	B	-	-	Morrow	Chester	Chesterville
350	120	JBI	B	-	-	Morrow	Chester	Chesterville
351	150	J BI	G	-	-	Morrow	Chester	Chesterville
352	84	JBI	B	-	-	Morrow	Chester	Chesterville
353	180	J BI	G	-	-	Morrow	Chester	Chesterville
354	190	J BI	G	-	-	Morrow	Chester	Chesterville
355	290	J BI	G	-	-	Morrow	Chester	Chesterville
356	132	J BI	G	-	-	Morrow	Harmony	Marengo
357	192	J BI	G	-	-	Morrow	Harmony	Marengo
358	30	KL	B	27	-	Morrow	Cardington	Ashley



APPENDIX B

Morrow County Till Analyses

# Morrow Co.

SAMP. NO.	SAND	SILT	CLAY	CAL.	DOLO.	TOT. CO <sub>2</sub>	FR. CLAS.	TILL Unit
1	26.6	41.8	31.6	0.5	6.4	6.9	ML	ML
2	29.7	41.5	28.8	2.5	8.7	11.2	KL	KL
3	27.7	31.4	40.9	1.5	3.3	4.8	ML	ML
4	30.5	48.3	21.2	3.0	14.9	17.9	KL	KL
5	30.8	39.0	30.2	0.0	3.0	3.0	?	JBI
6	25.4	42.9	31.7	0.0	6.5	6.5	KL	KL
7	24.6	49.5	25.9	0.7	5.8	6.5	?	JBI
9	21.3	46.6	32.1	0	1.9	1.9	ML	ML
11	30.8	45.0	24.2	1.7	4.2	5.9	KL	KL
12	20.2	51.6	28.2	0	4.6	4.6	?	ML
13	27.6	24.7	47.7	0	9.6	9.6	ML	ML
14	37.5	32.4	30.2	2.9	9.6	12.5	KL	KL
15	23.8	43.9	32.3	2.0	8.5	10.5	KL	KL
17	30.4	41.2	28.4	3.5	7.1	10.6	KL	KL
18	28.9	35.1	36.0	2.2	10.8	13.0	?	KL
19	26.7	36.9	36.4	0	8.7	8.7	ML	ML
20	28.2	39.6	32.2	1.8	8.0	9.9	KL	KL
21	30.0	51.8	18.2	0	3.5	3.5	KL?	JBI
22	29.3	44.8	25.9	3.5	4.2	7.7	?	JA
23	28.4	46.2	25.4	0	6.7	6.7	?	JBI
24	19.7	49.3	31.0	0	6.4	6.4	ML	ML
25	22.4	46.4	31.2	0	6.0	6.0	ML	ML
26	22.4	51.9	25.7	0	6.2	6.2	?	JBI
27	24.2	41.5	34.3	0	7.2	7.2	ML?	ML
28	26.6	49.7	23.7	0	4.6	4.6	?	JBI
29	28.7	49.5	21.8	0	7.8	7.8	?	JBI

SAMP. NO.	SAND	SILT	CLAY	CAL.	DOL.	TOT. CO <sub>3</sub>	Fld. class	Rev. Till Unit
30	28.1	48.4	28.1	2.5	8.9	11.4	J	JB IV
31	21.2	52.4	26.5	0	2.1	2.1	KL	KL
32	23.9	51.5	24.6	0	1.9	1.9	KL	KL
<del>33</del>	<del>29.4</del>	<del>50.2</del>	<del>28.4</del>	<del>0</del>	<del>0</del>	<del>0</del>	<del>ML</del>	<del>ground</del>
35	23.3	49.2	27.5	0	2.6	2.6	J	JB I
36	24.5	53.7	19.7	0	3.5	3.5	KL	KL
37	25.7	52.3	22.0	2.1	5.7	7.8	KL?	JB II
38	23.4	42.9	33.7	3.9	9.4	13.3	J	JB II
39	36.1	51.8	12.1	4.3	6.1	10.4	J	JB IV
<del>40</del>	<del>22.3</del>	<del>35.3</del>	<del>42.4</del>	<del>2.8</del>	<del>7.9</del>	<del>10.7</del>	<del>J</del>	<del>ground</del>
41	27.5	47.9	24.6	2.4	5.9	8.3	KL	KL
42	24.3	38.1	37.6	0.8	10.5	11.3	KL	KL
43	32.9	46.8	20.3	4.1	17.9	22.0	J?	JB II
44	30.0	58.9	11.2	0.9	6.5	7.4	J	JB III
45	36.1	44.5	19.4	8.8	14.8	23.7	J?	JA
47	30.9	60.6	8.5	4.4	10.9	15.3	KL	KL
48	28.7	47.1	24.2	5.2	8.2	13.4	J?	JA
49	29.7	39.7	30.6	3.8	11.0	14.8	KL?	KL
51	23.8	50.0	26.2	0	4.5	4.5	KL?	JB I
52	24.4	39.5	36.1	0	3.3	3.3	KL?	JB I
53	26.1	40.9	33.0	0	3.5	3.5	KL?	JB I
54	15.4	48.5	36.1	0	0	0	C	C
55	25.2	44.0	30.8	1.7	4.9	6.6	ML	ML
56	27.8	43.4	28.8	0.6	9.4	10.0	KL	ML
57	34.6	54.9	10.5	2.7	4.7	7.4	KL	KL
58	24.5	62.1	13.4	0	4.7	4.7	KL?	KL
34	25.9	47.6	26.5	0	5.3	5.3	ML	KL

SAMP. NO.	SAND	SILT	CLAY	CAL.	DOL.	TOT. CO <sub>2</sub>	Fid. class	FILL REV.
59 <sub>g</sub>	24.2	47.8	28.0	0	4.2	4.2	KL?	JBI
60	23.6	44.9	32.1	0	8.0	8.0	KL	KL
61	40.2	50.9	8.9	0	5.4	5.4	KL?	KL
62 <sub>g</sub>	30.3	44.7	25.0	0	6.4	6.4	J?	JBI
63 <sub>g</sub>	24.6	37.1	38.3	0	2.8	2.8	J	JBI
64	26.8	55.2	18.0	0	3.1	3.1	KL	KL
65	24.3	45.3	30.4	0	1.2	1.2	KL?	JBI
66 <sub>g</sub>	22.8	46.1	31.1	0.3	3.2	3.5	KL?	JBI
67	27.4	48.9	23.7	0.3	10.4	10.7	J	JBI
68	30.9	48.2	20.9	0.2	5.8	6.1	KL	KL
69 <sub>g</sub>	31.6	46.5	21.9	0.5	4.7	5.2	J	JBI
70 <sub>g</sub>	30.5	48.3	21.2	0.2	6.3	6.5	J	JBI
71 <sub>g</sub>	24.8	42.2	33.0	0	3.5	3.5	J	JBI
72	20.5	42.3	37.2	0	18.8	18.8	ML	ML
73	29.9	41.4	28.7	0	6.5	6.5	KL	KL
74	25.8	40.0	34.2	0	5.8	5.8	KL	KL
75 <sub>g</sub>	30.7	38.1	31.2	0	1.9	1.9	J	JBI
76 <sub>g</sub>	22.7	48.7	28.6	0	7.1	7.1	KL	KL
77	29.4	46.8	23.8	0	4.3	4.3	KL	KL
78	28.6	43.1	28.3	1.8	17.7	19.5	KL	KL
79	36.2	39.3	24.5	3.1	19.9	23.0	KL	KL
80	28.9	31.7	39.4	0.8	10.6	11.4	ML	ML
81	32.7	44.5	22.8	0.8	4.5	5.3	KL?	KL
82 <sub>g</sub>	31.0	47.5	21.5	0	5.0	5.0	J	JBI
83 <sub>g</sub>	29.0	49.1	21.9	0.9	7.4	8.3	KL?	KL
84	34.4	38.6	27.0	0	3.7	3.7	KL	KL

SAMP. NO.	SAND	SILT	CLAY	CAL.	DOU.	TOT. CO <sub>2</sub>	Fld. <sup>TILL</sup> Class <sub>Unit</sub>	Rev.
86	30.7	34.0	35.3	1.0	10.1	11.1	KL?	KL
87	21.7	56.0	22.3	0	3.7	3.7	ML	ML
88	26.0	40.9	33.1	1.5	4.6	6.1	KL	KL
89	20.8	50.3	28.9	3.2	8.5	11.7	C	C
90	23.1	48.8	28.1	4.6	9.8	14.4	ML	ML
91	25.7	47.4	26.9	3.5	12.4	15.9	KL?	KL
92	25.3	44.0	30.7	7.3	11.5	18.8	ML	ML
93	27.8	38.3	33.9	5.4	10.1	15.5	KL	KL
94	33.2	36.4	30.4	5.7	10.1	15.8	KL	KL
95	26.2	41.2	32.6	3.1	8.6	11.7	J	JB II
96	28.5	41.6	29.9	0.7	7.8	8.5	J	JB III
97	20.9	45.3	33.8	5.1	7.5	12.6	ML	ML
98	25.9	40.9	33.2	6.8	7.5	14.3	KL?	JA
99	28.7	42.8	28.5	1.5	15.5	17.0	J	JB IV
100	31.3	44.9	23.8	0	10.4	10.4	KL	KL
101	29.1	44.6	26.3	0	8.2	8.2	KL	KL
102	31.3	46.0	22.7	0.5	11.5	12.0	KL	KL
103	31.6	42.9	25.5	0.7	12.0	12.7	J	JB III
104	30.5	45.5	24.0	0	4.4	4.4	J	JB III
105	25.9	46.8	27.3	0	9.4	9.4	KL	KL
106	36.6	33.1	30.3	3.4	9.2	12.6	KL	KL
107	21.8	40.8	37.4	0	6.9	6.9	KL	KL
108	26.4	45.1	28.5	0.6	4.0	4.6	KL?	KL
109	22.9	45.5	31.6	0	4.6	4.6	KL?	KL
110	24.3	42.0	33.7	2.6	12.7	15.3	ML?	ML
111	26.2	38.8	35.0	0	4.9	4.9	KL	KL

SAMP. NO.	SAND	SILT	CLAY	CAL.	DO <sub>L</sub>	TOT. CO <sub>2</sub>	Fld. <sup>T. 1.0</sup> class	Rev.
112	25.0	41.6	33.4	5.0	5.3	10.3	ML	ML
113	27.3	37.8	34.9	4.0	6.5	10.5	KL	KL
114	24.4	50.8	24.8	2.5	13.7	16.2	C	C
115	23.2	41.0	35.8	3.5	6.9	10.4	ML	ML
116	32.6	38.0	29.4	0	4.6	4.6	JA	JB I
117	27.5	49.5	23.0	0.1	8.4	8.5	JA	JB I
118	25.5	50.8	23.7	0	7.4	7.4	JA	JB I
119	28.0	44.0	28.0	6.5	25.1	31.6	JA	JB II
120	36.8	34.4	28.8	6.2	21.7	27.9	JA	JB II
121	35.3	44.9	19.8	0.5	4.9	5.4	JA	JB III
122	32.2	47.6	20.2	0.8	10.1	10.9	JA	JB III
123	38.2	51.4	10.4	2.1	11.1	13.2	JA	JB IV
124	21.5	48.6	29.9	0.6	2.6	3.2	KL	KL
125	37.1	27.3	35.6	8.5	16.7	25.2	JA	JA
126	28.1	49.4	22.5	0	4.2	4.2	JA	JB I
127	37.9	36.9	25.2	0.5	4.9	5.4	JA	JB I
128	27.9	45.3	26.8	0	3.7	3.7	JA	JB I
129	31.3	47.2	21.5	1.0	3.7	4.7	JA	JB I
130	32.0	52.6	15.4	0	3.3	3.3	JA	JB I
131	32.9	44.3	22.8	0	4.2	4.2	JA	JB I
132	29.5	51.1	19.4	1.3	-3.3	4.6	KL	KL
133	37.9	42.9	19.2	4.4	7.8	12.2	KL	KL
134	25.4	46.9	27.7	4.3	6.0	10.3	ML	ML
135	26.1	46.9	27.0	6.9	5.5	12.4	ML	ML
136	22.4	41.1	36.5	2.4	5.3	7.7	KL	KL
137	24.9	42.1	33.0	2.2	4.6	6.8	ML	ML

SAMP. NO.	SAND	SILT	CLAY	CAL.	DOL.	TOT. CO <sub>3</sub>	Fld. class	Rev. <small>TILL Unit</small>
138	25.5	46.8	27.7	3.7	7.8	11.5	ML	ML
139	23.1	39.0	37.9	6.2	4.6	10.8	ML?	ML
140	26.2	27.1	46.7	4.5	7.2	11.7	?	JA
<del>141</del>	<del>20.2</del>	<del>41.9</del>	<del>37.9</del>	<del>3.0</del>	<del>2.0</del>	<del>21.1</del>	<del>ML</del>	<del>ML</del>
142	23.5	46.0	30.5	4.8	5.6	10.4	ML?	ML
143	25.9	45.4	28.7	4.6	14.9	19.5	ML?	JB.II
144	23.0	58.8	18.2	0.5	6.1	6.6	KL?	KL
<del>145</del>	<del>no sample</del>	<del>Loess</del>	<del>no sample</del>					
146	24.4	36.5	39.1	2.6	6.8	9.4	ML	ML
147	24.4	36.6	39.0	3.2	10.0	13.2	C	C
148	21.8	36.8	41.4	4.3	12.3	16.6	KL	KL
149	24.0	33.1	42.9	7.4	13.9	21.3	ML	ML
150	28.1	35.2	36.7	5.7	13.2	19.0	KL	KL
151	23.5	52.0	24.5	0	3.7	3.7	KL	KL
152	24.7	56.0	19.3	0	2.8	2.8	J	JB.I
153	24.4	49.1	26.5	0	9.2	9.2	ML?	ML
154	24.7	51.0	24.3	0	7.6	7.6	KL	KL
155	25.5	46.7	27.8	0	6.7	6.7	J	JB.I
156	30.8	44.3	24.9	2.9	4.9	7.8	J	JL
157	23.5	52.5	24.0	0	3.0	3.0	KL	KL
158	25.4	50.4	24.2	0	2.4	2.4	KL?	KL
161	25.5	50.0	24.5	0	3.3	3.3	ML?	KL
162	39.0	47.8	13.2	1.2	6.3	7.5	KL	KL
163	24.1	48.0	27.9	0	1.7	1.7	KL?	KL
164	22.2	48.3	29.5	0	5.3	5.3	? ML	ML
165	29.3	44.4	26.3	0	1.4	1.4	KL?	KL

SAMP. NO.	SAND	SILT	CLAY	CAL.	DOL.	TOT. CO <sub>2</sub>	Fld. class	REV. TILL Unit
166	27.6	46.8	25.6	0.5	4.6	5.1	J	JBI
167	24.5	49.9	25.6	4.6	4.4	9.0	KL	KL
168	24.6	48.1	27.3	4.8	11.5	16.3	J	JA
169	27.2	49.5	23.3	2.2	10.2	12.4	J	JBIV
170	23.0	42.9	34.1	4.9	14.0	18.9	ML	ML
171	27.5	46.6	25.9	4.2	13.3	17.5	ML	ML
172	27.9	49.3	22.8	4.2	12.6	16.9	KL	KL
173	11.5	48.2	40.3	2.4	6.3	8.7	C	C
174	10.6	35.4	54.0	5.7	13.2	19.0	ML	C
175	33.5	48.2	18.3	3.8	9.0	12.8	KL	KL
176	25.4	48.9	25.7	0	3.7	3.7	KL	KL
177	32.2	48.7	19.1	3.5	13.1	16.6	KL	KL
178	26.5	47.6	25.9	0	5.3	5.3	J	JBI
179	19.9	51.7	28.4	0	4.9	4.9	J	JBI
180	19.7	57.0	23.3	0	3.5	3.5	J	JBI
181	19.3	49.0	31.7	0	4.6	4.6	ML	ML
182	22.9	44.2	32.9	0.6	1.9	2.5	KL	KL
183	23.7	41.9	34.4	0	2.6	2.6	KL	KL
184	27.3	49.6	23.1	0.3	3.9	4.3	J	JBI
185	29.4	48.8	21.8	0.4	3.3	3.7	J	JBI
186	23.5	54.6	21.9	0.4	2.1	2.5	J	JBI
187	26.6	51.2	22.3	0	5.2	5.2	J	JBI
188	25.4	50.0	24.6	1.3	4.7	6.0	J	JBIV
189	21.2	47.3	31.6	0	3.3	3.3	KL	KL
190	24.6	44.0	31.4	0	3.1	3.1	J	JBI
191	27.6	46.8	25.5	0	3.1	3.1	J	JBI

SAMP. NO.	SAND	SILT	CLAY	CAL.	DOL.	TOT. CO <sub>2</sub>	Field class	Rev	Till Unit
192	45.5	41.4	13.0	3.6	12.8	16.4	<del>X</del>		JBII
193	31.2	49.6	19.7	0.4	8.6	9.0	<del>KL</del>		KL
194	29.2	44.2	26.6	3.5	13.7	17.2	<del>KL</del>		KL
195	18.2	49.3	32.6	0	3.5	3.5	<del>P.</del>		ML
196	21.6	40.3	38.1	0	2.6	2.6	<del>ML</del>		ML
197	29.0	45.5	25.5	0	2.8	2.8	<del>KL</del>		KL
198	24.7	43.3	32.0	0	5.2	5.2	<del>ML</del>		ML
199	26.0	42.6	31.4	2.3	1.7	3.9	<del>KL</del>		KL
200	31.5	43.0	25.6	6.2	19.7	25.9	<del>X</del>		JBII
201	25.2	42.6	32.1	0.0	10.0	10.0	<del>KL</del>		KL
202	41.5	33.0	25.5	3.6	9.6	13.2	<del>P.</del>		KL
203	36.6	39.5	23.9	5.0	5.3	10.2	<del>P.</del>		KL
204	40.3	40.7	19.0	7.6	12.9	20.5	<del>P.</del>		JBII
205	36.8	33.4	29.8	1.0	5.1	6.1	<del>X</del>		JBII
206	26.6	43.6	29.8	1.4	6.0	7.4	<del>KL</del>		KL
207	27.8	40.0	32.2	6.0	16.3	22.3	<del>KL</del>		KL
208	26.3	47.3	26.4	2.7	9.9	12.6	<del>ML</del>		ML
209	23.6	44.1	32.3	0.1	9.7	9.8	<del>ML</del>		ML
210	31.6	43.1	25.3	0.7	7.4	8.1	<del>KL</del>		KL
211	26.5	45.6	27.9	0	8.3	8.3	<del>ML</del>		ML
212	24.7	43.3	32.0	5.7	7.2	12.9	<del>ML</del>		ML
213	24.0	46.6	29.4	2.6	7.2	9.8	<del>KL</del>		C
214	23.1	44.8	32.1	4.6	9.9	14.5	<del>ML</del>		ML
215	24.0	41.1	34.9	5.2	12.4	17.6	<del>ML</del>		ML
216	23.2	39.0	37.8	6.6	13.1	19.7	<del>C.</del>		C
217	22.1	49.3	28.6	6.5	9.4	15.9	<del>ML</del>		ML

SAMP. NO.	SAND	SILT	CLAY	CAL.	DOLO.	TOT. CO <sub>2</sub>	Fld. class	REV.	TILL
218	32.5	46.8	20.7	0	5.8	5.8	J?	JBI	
219	21.1	43.8	35.1	2.4	10.6	13.0	C?	C	
220	18.8	18.8	62.4	4.5	7.1	11.6	J?	JA	
221	25.1	38.4	36.5	3.7	9.0	12.7	J?	JA	
222	24.8	39.1	36.1	6.7	10.8	17.5	J?	JA	
223	20.5	49.9	29.6	1.3	9.9	11.2	C?	C	
224	23.0	50.7	26.3	5.4	8.5	13.9	ML?	ML	
225	24.7	37.6	37.7	2.7	7.7	10.4	ML	ML	
226	18.5	52.8	28.7	4.0	3.3	7.3	C?	C	
227	24.8	58.2	17.0	8.6	6.3	14.9	ML?	ML	
228	22.7	63.8	13.5	5.5	17.4	22.9	ML	ML	
229	22.0	59.6	18.4	4.0	20.1	24.1	ML	ML	
230	21.7	42.1	36.2	6.1	15.1	21.2	ML?	ML	
231	29.0	35.3	35.7	0	6.1	6.1	KL	KL	
232	17.8	25.4	56.8	5.6	9.2	14.8	ML	ML	
233	22.4	27.4	50.2	6.6	12.7	19.3	ML	ML	
234	29.1	44.4	26.5	7.1	13.8	20.9	KL?	JA	
235	23.4	43.8	32.8	5.2	13.8	19.0	J?	JA	
236	31.4	45.3	23.3	0	4.7	4.7	J?	JBI	
237	30.7	38.1	31.2	0	5.8	5.8	J?	JBI	
238	23.6	47.4	29.0	0.5	6.3	6.8	ML?	ML	
239	28.7	50.2	21.1	6.5	14.7	21.2	ML	ML	
240	26.3	49.9	23.8	6.5	14.7	21.2	KL?	KL	
241	26.9	43.8	29.3	6.0	9.1	15.1	J?	JA	
242	27.4	42.2	30.4	5.2	11.8	17.0	J?	JA	
243	24.8	46.3	28.9	3.2	8.5	11.7	KL	KL	

SAMP. NO.	SAND	SILT	CLAY	CAL.	DOL.	TOT. CO <sub>3</sub>	Exp. Class	Soil Unit
244	26.0	43.3	30.7	0.3	9.4	9.7	ML	ML
245	24.7	42.8	32.5	2.1	1.5	3.6	ML	ML
246	33.4	43.9	22.7	6.6	14.6	21.2	KL	KL
247	19.1	42.3	38.6	0	4.2	4.2	KL	KL
248	23.4	48.2	28.4	0	4.4	4.4	KL	KL
249	30.8	39.8	29.4	6.9	8.9	15.8	ML	ML
250	27.7	45.0	27.3	1.6	3.1	4.7	KL	KL
251	26.5	42.3	31.2	0.8	3.8	4.6	JBI	JBI
252	29.5	47.5	23.0	0	4.0	4.0	JBI	JBI
254	27.1	46.4	26.5	5.6	6.6	12.2	ML	ML
255	24.9	38.2	36.9	1.8	15.4	17.2	ML	ML
256	27.9	35.0	37.1	2.9	15.2	18.1	KL	KL
257	21.5	38.4	40.1	0	1.9	1.9	ML	ML
258	27.1	40.9	32.0	2.6	17.4	20.0	KL	KL
259	23.4	39.3	37.3	2.5	9.2	11.7	ML	ML
260	35.2	41.4	23.4	3.1	16.5	19.6	KL	KL
261	22.8	29.1	48.1	2.5	8.3	10.8	KL	KL
262	21.8	43.3	34.9	5.3	4.4	9.7	ML	ML
263	24.7	44.4	30.9	7.5	7.4	14.9	ML	ML
264	28.1	47.1	24.8	2.2	9.4	11.6	ML	ML
265	30.3	50.2	19.5	3.2	10.4	13.6	KL	KL
266	18.6	53.3	28.1	1.5	4.4	5.9	C	C
267	20.4	51.5	28.1	5.3	3.0	8.4	ML	ML
268	18.1	61.2	20.7	0.6	2.8	3.4	C	C
269	20.0	36.0	44.0	4.8	4.2	9.0	ML	ML
270	22.0	48.9	29.1	5.2	5.8	11.0	KL	ML

SAMP. NO.	SAND	SILT	CLAY	CAL.	DOLO.	TOT. CO <sub>2</sub>	FL. CHAS.	REV. Till Unit
271	34.4	46.1	19.5	2.1	6.0	8.1		JBIV
272	32.1	49.8	18.1	2.5	13.6	16.1		JBIV
273	37.4	53.5	9.1	1.3	10.2	11.5		JBIV
274	35.7	47.5	16.8	1.9	11.8	13.7		JBIV
275	31.4	51.0	17.6	3.0	9.5	12.5		JBIV
276	37.6	41.9	20.5	2.6	18.2	20.8		JBIV
277	30.1	39.1	30	0	9.5	9.5		KL
278	29.9	43.4	26.7	0.4	13.0	13.4		KL
279	28.9	42.0	29.1	1.1	8.8	9.9		JBIII
280	26.7	40.9	32.4	0.7	6.8	7.5		BI
281	29.1	41.5	29.4	1.0	4.5	5.5		KL
282 <sup>1st</sup>	34.4	45.4	20.2	10.4	7.4	17.8		ML
283	34.6	37.7	27.7	0.3	4.9	5.2		KL
284	27.1	46.2	26.7	0.3	3.5	3.8		KL
285	31.9	53.0	15.1	0	4.9	4.9		KL
286	26.0	49.4	24.6	0.4	7.6	8.0		KL
287	31.7	44.7	23.6	1.5	4.0	5.5		KL
288	30.2	39.3	30.5	0.4	7.0	7.4		JB I
289	23.0	37.9	39.1	3.9	5.4	9.3		ML
290	26.0	35.1	38.9	4.5	7.4	11.9		KL
291	30.7	40.1	29.2	2.9	-6.5	9.4		KL
292	33.4	30.3	36.3	3.1	12.5	15.6		KL
293	30.4	45.4	24.2	2.2	4.9	7.1		JB I
294	29.0	36.3	34.7	0	2.6	2.6		JB I
295	29.5	45.3	25.2	0	8.6	8.6		KL
296	26.6	35.2	38.2	1.8	7.9	9.7		KL

SAMP. NO.	SAND	SILT	CLAY	CAL.	DOL.	TOT. CO <sub>2</sub>	Fld. Class	REV. TILL
297	17.8	43.1	39.1	1.7	4.9	6.6	ML	ML
298	23.9	49.7	26.4	4.6	4.7	9.3	ML	ML
299	22.6	47.7	29.7	6.4	8.4	14.8	KL	KL
300	18.2	42.0	39.8	3.8	7.9	11.7	ML	ML
301	18.0	30.7	51.3	1.4	7.0	8.4	KL	KL
302	21.8	32.6	45.6	2.6	6.8	9.4	ML	ML
303	21.5	50.4	28.1	5.5	7.5	13.0	ML	ML
304	25.1	47.9	27.0	6.0	7.0	13.0	KL	KL
305	24.7	40.9	34.4	5.9	9.8	15.7	ML	ML
306	25.9	49.7	24.4	4.5	8.6	13.1	J?	JA
307	10.1	59.1	30.8	5.2	7.9	13.1	C	C
308	21.5	45.5	33.0	3.2	10.9	14.1	ML	ML
309	22.7	49.1	28.2	4.8	3.7	8.5	KL	KL
310	25.1	44.1	30.8	5.5	6.3	11.8	ML	ML
311	15.6	44.8	39.6	1.1	3.8	4.9	C	C
312	31.1	55.3	13.6	6.2	7.0	13.2	JA	JA
313	34.5	51.5	14.0	1.3	4.4	5.7	KL	KL
314	30.8	50.5	18.7	0	7.2	7.2	KL	KL
315	32.3	45.5	22.2	3.8	7.9	11.7	JA	JA
316	17.0	51.6	31.4	0	2.6	2.6	ML	ML
317	34.4	46.2	19.4	0.8	5.2	6.0	KL	KL
318	15.8	57.4	26.8	0	1.7	1.7	C	C
319	30.7	46.5	22.8	2.7	4.5	7.2	KL	KL
320	29.3	46.5	24.2	1.2	5.2	6.4	KL	KL
321	25.3	30	44.7	0	8.1	8.1	KL?	KL
322	24.6	36.4	39.0	5.8	9.7	15.5	ML?	ML

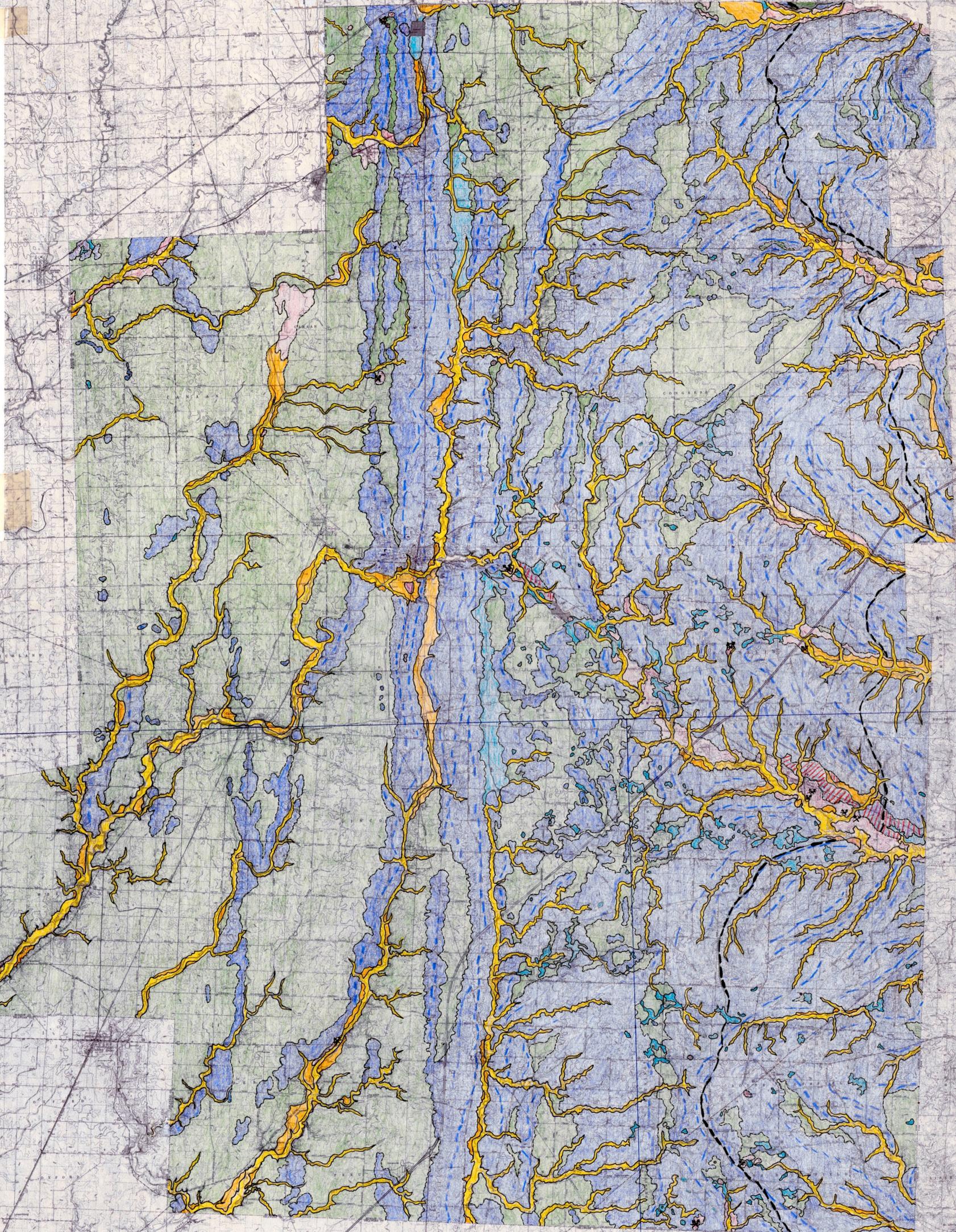
SAMP. NO.	SAND	SILT	CLAY	CAL.	DO <sub>L</sub>	TOT. CO <sub>2</sub>	Fld. class	Rev. TILL unit
323	23.0	52.5	24.5	7.0	10.4	17.4	KL?	KL
324	24.8	50.3	24.9	6.2	12.0	18.2	ML	ML
325	24.7	49.4	25.9	0.3	5.6	5.9	ML?	ML
326	27.8	50.0	22.2	1.0	9.0	10.0	J?	JB III
327	21.3	40.1	38.6	0	3.3	3.3	C	C
328	24.9	52.3	22.8	8.6	4.8	13.2	KL	KL
329	26.0	45.4	28.6	2.2	4.0	6.2	ML	ML
330	37.1	42.5	20.4	5.2	6.4	11.6	J	JA
331	36.6	38.2	25.2	5.0	10.5	15.5	J	JA
332	25.0	43.4	31.6	0	1.5	1.5	J?	JB I
333	24.7	44.0	31.3	0	2.6	2.6	KL	KL
337	26.3	38.1	35.6	3.8	12.2	16.0	J	KL
338	24.9	36.1	39.1	5.9	14.0	19.9	KL	KL
339	25.2	33.0	41.8	4.9	14.7	19.6	J	JB II
340	24.8	41.4	33.8	2.6	11.3	13.9	J?	JB IV
341	31.9	39.1	29.0	6.5	15.6	22.1	KL	KL
342	23.0	40.6	36.4	0	4.9	4.9	ML?	ML
343	26.1	47.0	26.9	0	7.6	7.6	KL?	JB I
344	27.1	42.1	30.8	0	6.9	6.9	J?	JB I
345	23.7	39.5	36.8	0.4	7.1	7.6	J?	JB I
346	24.0	47.2	28.8	0	11.1	11.1	ML	ML
347	27.7	44.8	27.5	0	4.3	4.3	J?	JB I
348	29.9	38.3	31.8	0	5.0	5.0	J?	JB I
349	30.0	42.9	27.1	0.4	2.0	2.4	KL?	KL
350	29.9	45.3	24.8	0	4.1	4.1	J?	JB I
351g	27.9	48.1	24.0	0	7.8	7.8	J	JB I



1925

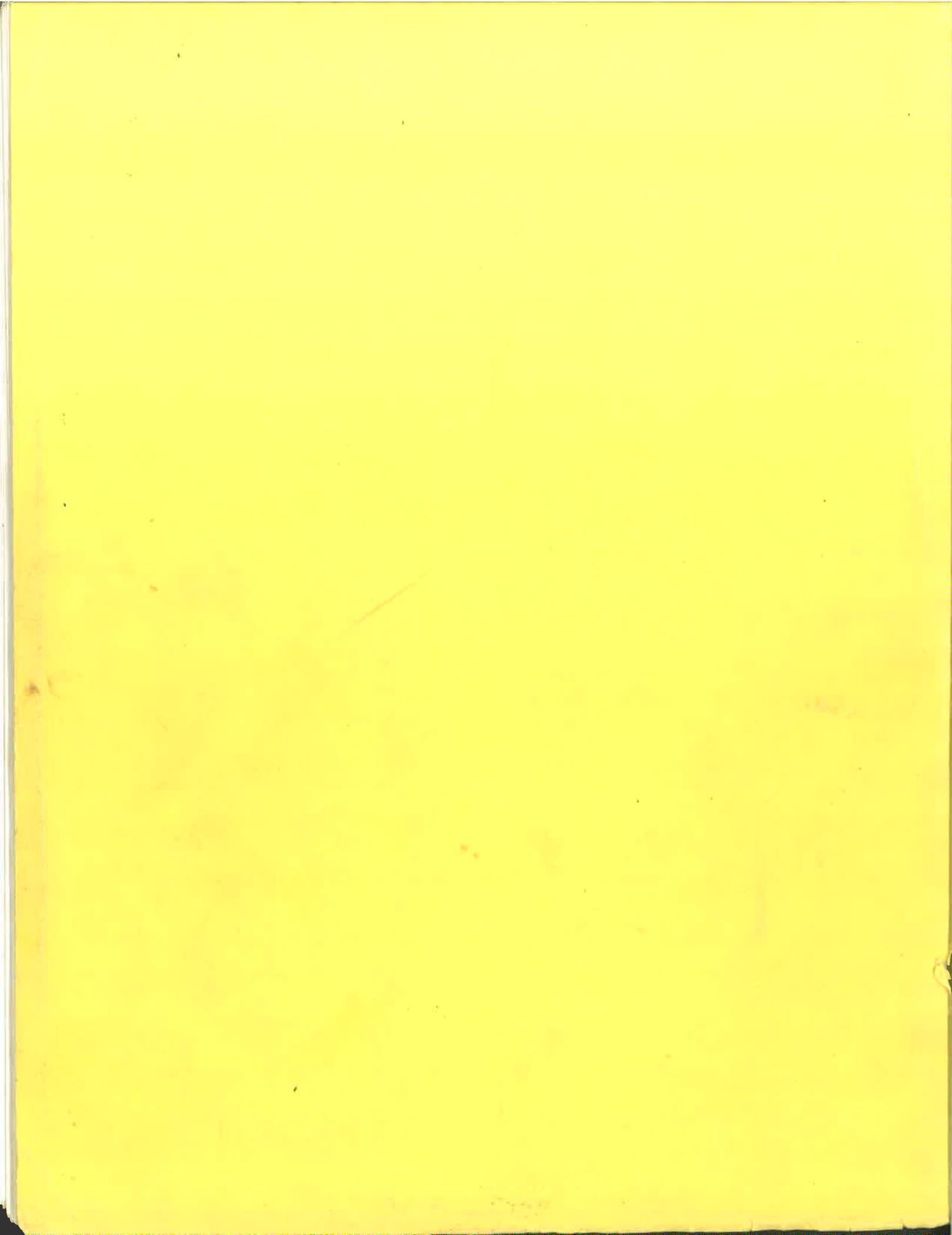
Glacial Geology of Morrow County, Ohio  
Stanley M. Totten

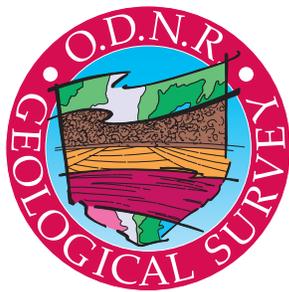
- Explanation
- Recent  Alluvium. Silt, sand and gravel in stream channels and on floodplains. Thickness is highly variable.
  - Wisconsinan  Alluvial Deposits. Silt, sand and gravel of variable thickness deposited in valleys and preserved as terraces along valley sides. Mainly valley train deposits of glacial outwash.
  -  Lake Deposits. Sand, silt, clay, muck and peat of variable thickness deposited in kettle holes and in valleys dammed by end moraines.
  -  Kames and Kame Terraces. Gravel and sand in knolls or in terraces; overlain by till in many places.
  -  End Moraine. Hummocky topography having linear trend. Thin Centerburg and Mt. Liberty tills at surface underlain by older tills. Bulk of moraine consists of Jelloway Till.
  -  Gravelly Moraine. Knolls consisting of till at surface, with masses of gravel likely at depth.
  -  Ground Moraine. Gently rolling topography. Thin Centerburg and Mt. Liberty tills underlain by older tills.
  -  Gravel Pit, active
  -  Gravel Pit, small or abandoned
  -  Centerburg Till boundary (approximate)
  -  Crestlines of end moraine elements



Glacial Geology  
of  
Morrow County  
by  
S. Totten  
1985

MORROW  
1985





Ohio Department of Natural Resources  
Division of Geological Survey  
2045 Morse Road, Bldg. C-1  
Columbus, OH 43229-6693  
Telephone: (614) 265-6576  
Fax: (614) 447-1918