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The Artificial Drainage in Lorain County, Ohio

Jessie Rose Turk
Oberlin College

THE ARTIFICIAL DRAINAGE

IN

LORAIN COUNTY, OHIO

By
Jessie Rose Turk
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Preface

The purpose of this thesis is to explain why artificial drainage is necessary in Lorain county, Ohio, and how it has been accomplished under county supervision.

Artificial drainage is the process of removing an excess of water from the soil by means of open ditches or underground drains. Its main purpose is to improve the condition of the soil for agriculture. An organized drainage enterprise should provide adequate outlets into which the farms of the district may be tile drained, and should provide relief for the region as a unit.

The maps showing the location of the county ditches and drains were made from Lorain county ditch records and maps and checked with aerial photographs of the county. The beach ridges in the county, as shown in Plate I and figure 5, are taken from the unpublished maps by Frank Carney which show the abandoned shorelines of the glacial lakes in the Vermilion and Oberlin topographic quadrangles.

The writer wishes to thank her advisor, Dr. Reuel B. Frost, for suggesting the topic and for his assistance in the preparation of this thesis. She wishes to thank Dr. Fred Foreman for his aid in finding materials and in interpreting aerial photographs. The location of the soil

types and their descriptions were made possible by consulting, through correspondence, with Dr. George W. Conrey of the Department of Agronomy, Ohio State University. The writer is indebted also to Mr. Lester W. Osborn, Sanitary Engineer of Lorain county, without whose assistance this thesis could not have been written.

J. R. T.

Part I: The Reasons for Artificial Drainage in Lorain County

A. The Reclamation Area

1. The Great Lakes States

The artificial drainage enterprises in Lorain county, Ohio, are a part of the glacial swamp and wet lands reclamation area of the Great Lakes states. Most of the drainage enterprises of this reclamation area are concentrated in a region comprising the southern half of Michigan, the northeastern half of Indiana, and the northwestern third of Ohio. The need for artificial drainage in this area is due mainly to the effects of the Wisconsin ice-sheet in general, and in particular to the Saginaw lobe in Michigan and to the Huron-Erie lobe in Michigan, Indiana and Ohio.[1] The advancing ice-sheet tended to "level" the area. As the ice-sheet retreated morainic deposits of drift were left unevenly distributed over the area. Melt waters gave rise to a series of pro-glacial lakes. As a result there are extensive areas of relatively flat pro-glacial lake beds, also many kettles in the drift in this reclamation area. The natural gradient of the youthful lake beds is not great enough to afford good drainage; the presence of old lake shores in the form of "beach ridges" further impedes the flow of surface water into the Great Lakes system, and water

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1. N. M. Fenneman, Physiography of the Eastern United States, McGraw-Hill Book Co., New York, 1938, pp. 477-518.

tends to become impounded behind the ridges. In the short period since the withdrawal of the glacial ice-sheets, due to the lack of natural drainage lines extensive swamps developed in many of the level to depressed areas in the drift. In many places in the drift and in the pro-glacial lake beds, the glacial till and lake bed soils, varying from heavy clay to sandy loam, are too wet for the best agricultural use without artificial drainage. At present, Michigan has twenty-five per cent of its area in drainage enterprises, Indiana, forty-four per cent, and Ohio, thirty-one per cent.[1]

2. Ohio

The reclamation area of Ohio is confined to the Lake and Till Plains area (see fig. 1). The drainage enterprises of northwestern Ohio are especially concentrated north of the divide between the land draining south to the Ohio River system and the land draining north to Lake Erie. The Lake Plain, which runs roughly parallel to the southern shore of Lake Erie, increases in width as it extends southwestward. South of a point near Cleveland the Lake Plain is three miles wide and increases to a maximum width of a

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1. G. J. Miller, "Reclamation of Wet and Overflow Lands", Our Natural Resources and Their Conservation, A. E. Parkins and J. R. Whitaker, eds., Wiley and Sons, New York, 1939, Chapt. VIII, pp. 162-164.

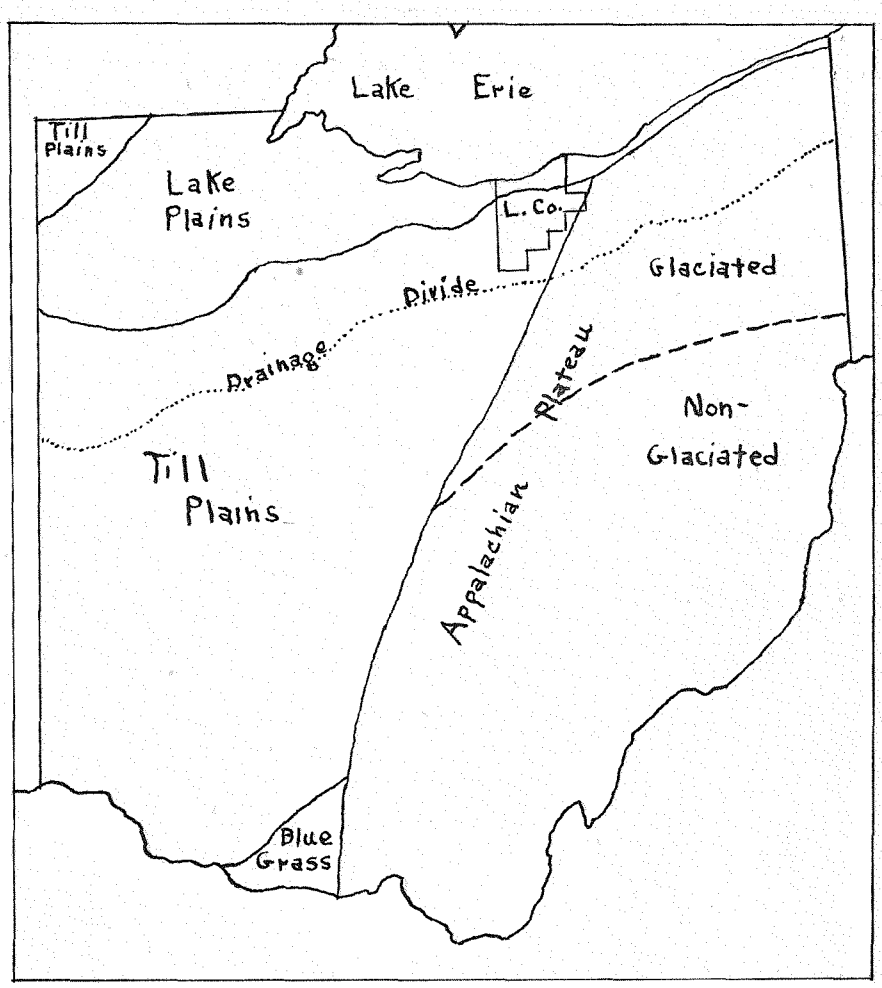

Figure 1. Physiographic Areas of Ohio

little more than fifty miles, south of Toledo. From a point on the Ohio-Indiana border where the Maumee River crosses the state line, proceeding northeast to the shore of Lake Erie, near Toledo, the Lake Plain has a width of eighty-one miles. The consequent slope of the Lake Plain in this area is 2.14 ft. per mile or about 0.04 per cent. The slope from Van Wert, Ohio, which is situated on the shoreline of glacial Lake Maumee (the oldest pro-glacial lake in Ohio), proceeding slightly east of north to Defiance, Ohio, which is situated on the Defiance moraine, is two feet per mile or about 0.038 per cent. This is one of the flattest areas of any terrain in the world. The "flatness" of the Lake Plain gave rise to what the early pioneers named the "black swamp" area of northwestern Ohio. This is the area where the most extensive drainage enterprises have been necessary.

The consequent slope of the Till Plain in the northwestern part of Ohio is greater than is that of the Lake Plain area but not great enough to afford good natural drainage. From the Willow Branch Shhool (Wayne twp., Auglaize county), located on the St. Johns moraine, to Findlay, Ohio, located on the southern shoreline of glacial Lake Maumee, the consequent slope is 7.5 ft. per mile or about 0.142 per cent. This slope is not gradual for there are a series of recessional moraines between the two locations. These moraines interrupt the even flow of surface water to the north. Most of this Till Plain area has been artificially

drained.

3. Lorain County

Lorain county, a sample area, is located on the northeastern border of the Ohio reclamation area. In this county, drainage conditions of both Lake Plain and Till Plain are in evidence. To explain the nature of the drainage enterprises of an area such as Lorain county one must consider the controls of poor drainage: (1) Climate, (2) Topography and Natural Drainage, (3) Soil, (4) Natural Vegetation, along with the historical factors, all of which determine the need for and the pattern and type of artificial drainage.

B. Controls of Poor Drainage in Lorain County

1. Climate

The climate of Lorain county falls into Koeppen's Dfa classification since the average temperature of the coldest month is below 26.6° F., there is no distinct dry season and the average temperature of the warmest month is over 71.6° F. (See fig. 2). The county lies in the path of the cyclonic storms which move from the region of the Gulf of Mexico north and east toward the Atlantic Ocean. The precipitation is distributed fairly well throughout the year, no month having less than two inches. There are approximately sixty days of snowfall averaging about thirty-eight inches a year. The maximum rainfall comes in July. The means annual temperature for the county is 49° F. "The winters, however, are sufficiently cold that a shelf of ice 1 - 10 miles in width and 8 - 10 inches in thickness forms around the margins of Lake Erie and navigation is closed for three to four months".[1] The ground is frozen during the months of December, January and February and part of March.

Due to the tempering effect of Lake Erie, the climate of Lorain county is milder than that of other places in the same latitude which have a "continental" location. As a

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1. R. B. Frost, "Lorain, Ohio, A Study in Urban Geography", Ohio Journal of Science, Vol. 35, No. 3, May, 1935, p. 146.

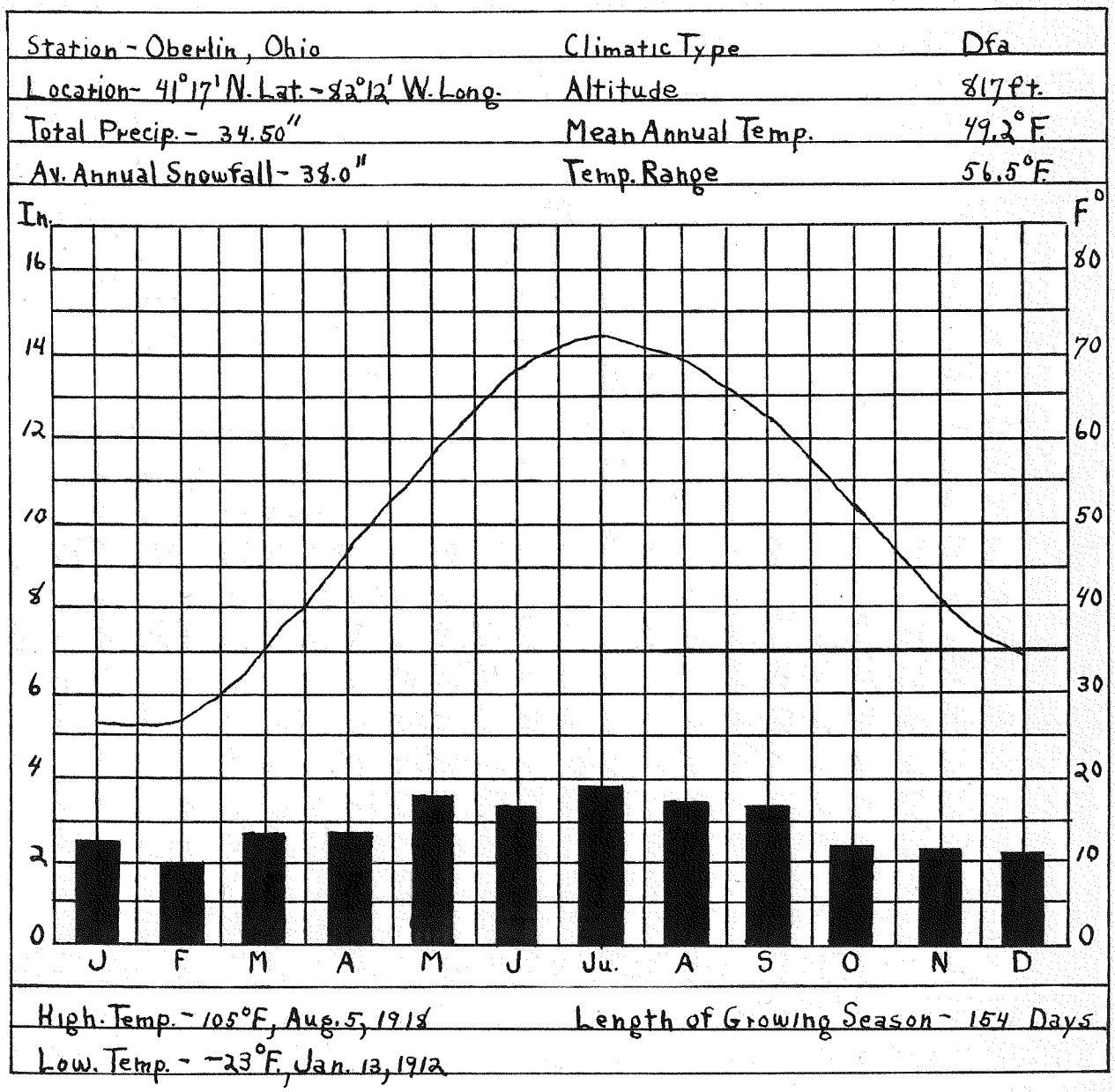

Figure 2. Climatic Chart: Oberlin, Lorain County, Ohio

result of the lake influence, the growing season in the county decreases from 192 days along the lake shore, 178 days about three miles south, 164 days about five miles south, to 150 to 164 days over the rest of the county.[1] This is contrary to the general rule that in the northern hemisphere the growing season decreases from south to north. Along the lake shore the average date for the first killing frost in autumn is October 30th and that of the last killing frost is April 15th.[2] In Oberlin, about ten miles south of the lake shore, the average date for the first killing frost is October 10th, and for the last killing frost May 8th.[3]

Artificial drainage must be adequate to deal with extremes of rainfall rather than with just the mean. In Lorain county it has been necessary to develop an artificial drainage system in order that the farmers might derive full benefits from the favorable growing season and make the best use of the soil. The melting snows, the thawing ground and the cyclonic storms cause much of the soil to become waterlogged in spring. When the excess moisture is removed from the earth, the soil becomes ready for tilling and seeding a

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1. K. Lindeman, Forest Resources of Lorain County, Ohio, Forestry Publication No. 68, O. Agric. Exp. Sta., Div. of Forestry, Wooster, Ohio, July, 1940, p. 2.

2. Frost, op. cit., p. 146.

3. W. H. Alexander, A Climatological History of Ohio, Bull. No. 26, Engin. Exp. Sta., Ohio State University, Columbus, Ohio, 1924, p. 442.

week or ten days earlier than when not drained.[1] The artificially drained soil usually is six to ten degrees warmer than undrained soil. This causes the seeds to germinate more readily and grow more promptly.[2] The artificial drainage system also prevents the fields of many areas from becoming water-logged or washed out by the heavy convectional storms during the summer months and the cyclonic storms in the autumn. In the areas which have been well drained, winter crops, such as clover, are not damaged by the heaving of the soil as is the case when wet clay soils become frozen.[3]

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1. C. C. Elliott, Drainage of Farm Lands, U. S. Dept. of Agric., Farm. Bull. No. 187, Gov. Print. Off., Washington, D. C., 1904, p. 5.

2. R. D. Marsden, "The Economy of Farm Drainage", Yearbook of the Department of Agriculture, 1914, Gov. Print. Off., Washington, D. C., 1914, p. 247.

3. Elliott, op. cit., pp. 27-28.

2. Topography and Natural Drainage

The need for artificial drainage in Lorain county is tied closely to the general glacial topography of the county and to the location of the natural river systems which are incapable of affording good drainage to the county as a whole. The elevation of the county rises from 573 feet above sea level at the shore of Lake Erie which borders the county at the north to 1120 feet above sea level on the Defiance moraine at the southern border of Huntington township, the southern boundary of the county. The consequent slope of the county from south to north is 19.9 feet per mile or 0.38 per cent. The divide between the land draining south to the Ohio River system and the land draining north into Lake Erie is located south of the county in the vicinity of Savannah Lakes (Ashland county). Consequently, all the surface water of Lorain county drains north into Lake Erie, mainly by way of the major river systems supplemented today by artificial drainage channels.

a. The Topographic Areas

As a result of glaciation in Ohio, Lorain county is divided into three topographic areas, the Lake Plains, the Till Plains and the Appalachian Plateau (See fig. 1), each having separate drainage controls. In Lorain county the

Appalachian Plateau extends only into the southeastern portion of Columbia township. The boundary between it and the Till Plains is mainly one of elevation, marked approximately by the 800 foot contour line east of the West Branch of Rocky River. The topography of the Appalachian Plateau consists of foothills, sharply dissected by numerous small tributaries of the West Branch of Rocky River. These tributaries flow generally northwest from the plateau to unite with the river on the Till Plains. The consequent slope of the plateau is sixty feet per mile or 1.14 per cent. This is 0.76 per cent greater than the general slope of the county. Although the plateau does not have the highest elevation, it presents the steepest slopes in the county. As a result of the consequent slope and the numerous streams, the Appalachian Plateau section has the best natural drainage of the three topographic areas.

The boundary between the Lake Plains at the north of the county and the Till Plains to the south is the shoreline of glacial Lake Maumee. This boundary is well marked in the eastern part of the county by a beach ridge, locally called Butternut Ridge, which runs northeast from La Porte (Carlisle township) and nearly parallels the Lake Erie shore. At present, state highway No. 10 runs along the ridge toward Cleveland.

The Lake Plains region rises 180 feet from north to

south in three step-like plains. The first, the glacial Lake Warren plain, rises from 590 to 635 feet above sea level and merges with the beach ridge known locally as the North Ridge. Proceeding southeast from the mouth of Black River this plain is about six miles wide. Its average consequent slope to the north is 7.5 feet per mile or 0.11 per cent. The second, the glacial Lake Whittlesey Plain, rises from 670 to 720 feet above sea level and merges with the beach ridge which, east of Black River, is known as Middle Ridge. Continuing southeast from the mouth of Black River and the Lake Warren plain, the Lake Whittlesey plain is about four miles wide and has an average consequent slope of 12.5 feet per mile or 0.24 per cent. The third, the glacial Lake Maumee plain, rises from 720 to 770 feet above sea level and is terminated by the Butternut Ridge. The Lake Maumee plain is approximately three miles wide, southeast of the mouth of Black River, and has an average consequent slope of 16.7 feet per mile or 0.32 per cent. The entire Lake Plains region southeast of the mouth of Black River is, therefore, about thirteen miles wide. Although the average slope of each lake plain is slightly less than the one preceding it to the south, the entire Lake Plains region gives the appearance of being "flat". In considering the natural drainage of the Lake Plains area, the average consequent slopes of the individual lake plains is not

as important as the varying slope of any one lake plain. In general the individual lake plains have a minimum slope of slightly less than ten feet per mile or 0.19 per cent at the north, which increases to about thirty feet per mile or 0.57 per cent as the abandoned shoreline (beach ridge) to the south is approached. Besides the three main ridges in the county there are a number of smaller, discontinuous ridges, such as Rocky Ridge (Ridgeville twp.), Sugar Ridge (Ridgeville twp.), Chestnut Ridge (Eaton and Ridgeville twps.) and Murray Ridge (Elyria and Carlisle twps.), lying between the main ridges. The sandy, gravelly ridges average twenty to thirty feet in height above the level of the lake plains, and vary in width up to a quarter of a mile. Each ridge has a remarkably even crest and stands out in contrast to the low level lake plains on either side. The well drained ridges, which run roughly parallel to the lake, act as a barrier to surface run-off water. The low consequent slopes of the lake plains further impedes the progress of drainage into Lake Erie. Before the region was artificially drained water became impounded on the south side of the ridges where numerous swamps developed. When crossing the Lake Plains area in 1755, James Smith noted: "Here the land is generally good, but I found some difficulty getting round swamps and pounds."[1] While the ridges

1. Col. James Smith, An Account of the Remarkable Occurrences in the Life and Travels of Col. James Smith During Captivity with the Indians, John Bradford, Lexington, 1799, p. 35.

are composed of sands and gravels, and drain quickly, the floors of the lake plains consist of unconsolidated lake clay deposits, four to ten feet thick, which are retentive of surface water and become sticky in wet weather.[1] Except for the beach ridges, the Lake Plains area as a whole has poor natural drainage.

The Till Plains region consists of nearly two-thirds of the land area of Lorain county. The glacial drift covering the area is thick and unevenly deposited, as the Till Plains rises toward the south, hence the Till Plains shows a slightly more rolling topography than the Lake Plains. From the Defiance moraine, which extends over the southern third of Rochester and Huntington townships, north to the glacial Lake Maumee ridge in Amherst township, the average consequent slope of the Till Plains is about 16.5 feet per mile or 0.30 per cent. The consequent slope of the Defiance moraine, sixty feet per mile or 1.14 per cent, equals the slope of the Appalachian Plateau area. The slope of the Till Plains north of the Defiance moraine is but 11.1 feet per mile or 0.20 per cent. The relief in the region of the Defiance moraine has been accentuated by the numerous valleys cut into the drift by the many tributaries of the West Branch of Black River. There are a few sandstone hills in the northwestern part of

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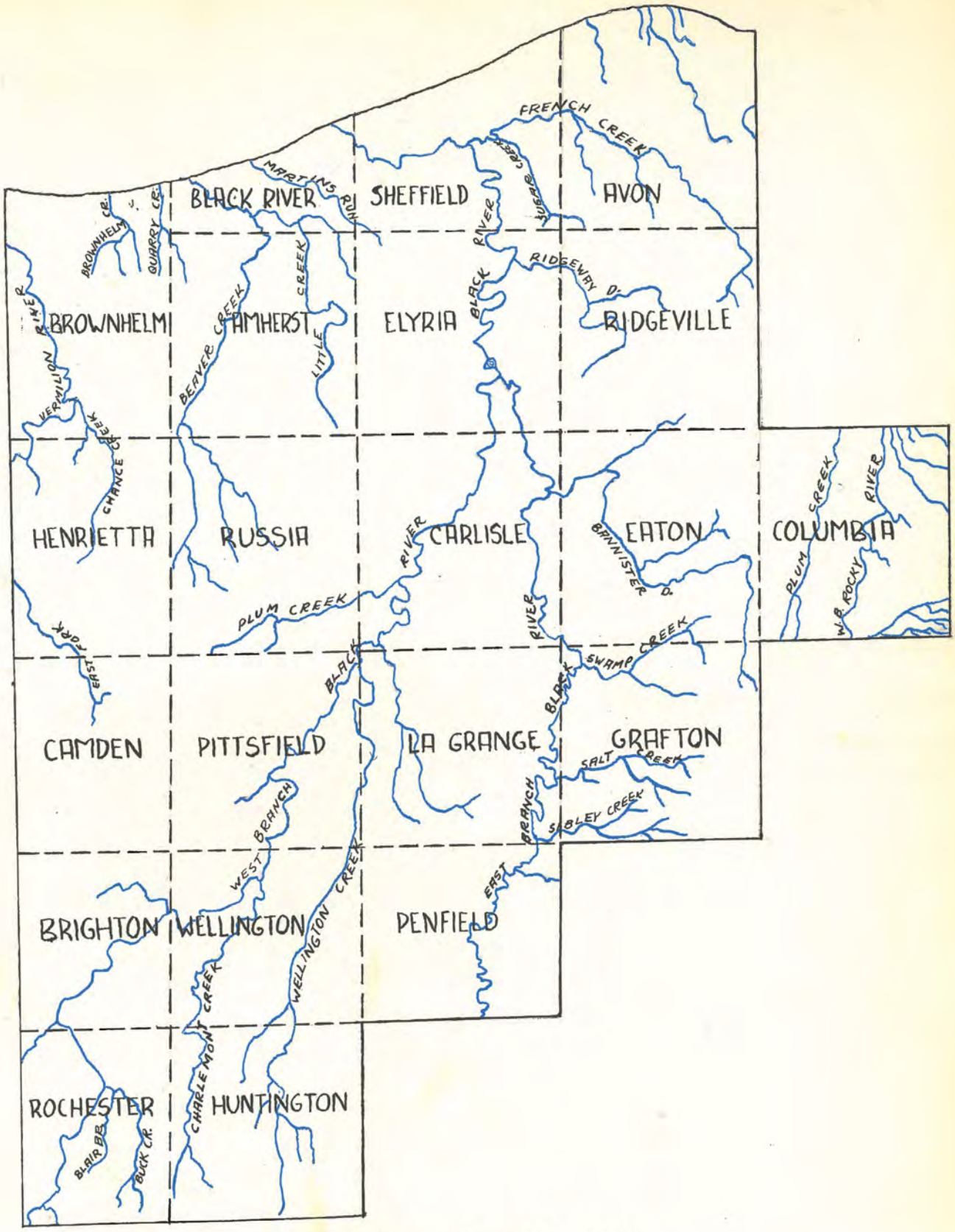
1. Frost, op. cit., pp. 143-144.

the Till Plains (Henrietta, Brownhelm, Amherst and Russia twps.), over which the glacial drift is thin. These are rounded and gently undulating. Where the major streams have cut gorges, and in places where they have widened their valleys to produce extensive bottomlands, the relief of the Till Plains is more pronounced. In general, the Till Plains have better natural drainage than the Lake Plains.

b. The River Systems

From west to east, the four major rivers in Lorain county are the Vermilion River, Beaver Creek, Black River and the West Branch of Rocky River (See fig. 3). The Vermilion River enters Lorain county at the northwestern corner of Henrietta township and flows north, a distance of about ten miles, through the western part of Brownhelm township, roughly parallel to the western boundary of the county, then leaves the county again before emptying into Lake Erie at the town of Vermilion in Erie county. The East Fork of the Vermilion River has its source in the north-central part of Camden township about a mile south of Kipton. It flows northwest through Camden and Henrietta townships for a distance of seven and a half miles before leaving the county to join the main river in Erie county. This stream with its tributaries drains the northwestern portion of Camden township and the southwestern portion of Henrietta township. Chance Creek, another tributary



Approximate Scale 1:250,000

Figure 3. The Rivers in Lorain County

of the Vermilion River, rises in the central part of Henrietta township and flows in a northerly direction through Henrietta township and the southern part of Brownhelm township for a distance of five miles before uniting with the Vermilion River. This creek with its tributaries, along with other small tributaries of the Vermilion River, drains the northern half of Henrietta township, except for a small region along the eastern border, which drains into the Beaver Creek system. The Vermilion River with its tributaries drains the northwestern part of Camden township, the western two-thirds of Henrietta township and the western half of Brownhelm township.

Between the drainage systems of the Vermilion and Black rivers, in the northern part of the county, Beaver Creek with its main tributary, Little Creek, drains the northwestern section of Russia township, Amherst township and the southern and western portions of Black River township. Beaver Creek proper, from its source in Russia township, flows north and northeast through Amherst township, then swings northwest in Black River township, a distance of about twelve miles to its mouth at Oak Point. Little Creek rises in the southeastern corner of Amherst township and flows in a general northerly direction before swinging west in Black River township to join with Beaver Creek. The length of Little Creek is about seven and a half miles.

The Black River system, the most important of the major stream systems in Lorain county, drains at least half of the land area of the county. The West Branch of Black River rises on the Defiance moraine just south of the southern border of Rochester township. This branch flows generally northeast from the southwestern corner of Rochester township through Rochester, Brighton, Wellington, Pittsfield and Carlisle townships into Elyria township to unite with the East Branch of Black River below the falls at Elyria. The length of the West Branch of Black River from its source to the confluence at Elyria is about thirty-seven miles. The West Branch of Black River has six main tributaries:

(1 & 2) Blair Brook (three and one-half miles long) and Buck Creek (six and three-quarter miles long), which are located to the east of the main river in Rochester township, flow north from the Defiance moraine to join the West Branch and drain the eastern half of Rochester township.

(3) Charlemont Creek, which rises at the southwestern corner of Huntington township and flows a distance of ten and three-quarter miles north through Huntington and Wellington townships nearly parallel to their western boundaries, joins the main stream in the north central part of Wellington township.

(4) Wellington Creek (sixteen and three-quarter miles long) rises on the Defiance moraine at the southern boundary

of Huntington township and flows generally north through the center of Huntington and Wellington townships to enter Pittsfield township at the southeastern corner, then flows along the Pittsfield-LaGrange boundary before uniting with the main stream at the northeastern corner of Pittsfield township. This creek drains the eastern half of Huntington, Wellington and Pittsfield townships.

(5) Elk Creek, a stream five and one-half miles long, rises in the southwestern part of LaGrange township and flows north through the western part of LaGrange township roughly parallel to Wellington Creek and joins the West Branch of Black River at the southwestern corner of Carlisle township.

(6) Plum Creek, the only main tributary to the west of the West Branch of Black River, rises at the Pittsfield-Russia boundary in the southwestern part of Russia township and flows for a distance of seven miles in a generally eastern direction through south Russia to unite with the larger river in the southwestern part of Carlisle township.

All the land, then, in the townships of Rochester, Brighton, Pittsfield, the western three-quarters of Huntington and Wellington, the eastern half of LaGrange and Carlisle, southeastern Elyria and the southern part of Russia drains into the West Branch of Black River either directly or by way of its tributaries.

The East Branch of the Black River rises on the Defiance moraine southeast of Lorain county in Harrisville township, Medina county. It enters Lorain county at the southern boundary of Penfield township and flows generally north through the eastern part of Penfield and LaGrange townships, the northwestern corner of Grafton township, the southwestern corner of Eaton township, and the eastern part of Carlisle township, into Elyria township, where the river roughly parallels the lower course of the West Branch of Black River to the confluence of the two branches at Elyria. The East Branch of Black River flows a distance of thirty-six and a half miles from its point of entry into the county to the confluence. This branch has four main tributaries in Lorain County all of which are located to the east of the river:

(1) Sibley Creek, which has its source in the southeastern part of Grafton township, flows west for five miles, draining the southern third of the township, before uniting with the East Branch at the southeastern corner of LaGrange township.

(2) Salt Creek (also known as Center Creek) rises just east of the center of Grafton township and flows west for five miles, draining the middle third of the township before joining the East Branch at the LaGrange-Grafton boundary line.

(3) Swamp Creek with its minor tributaries, which

rise in the northeastern part of Grafton township and the southeastern part of Eaton township, flows in a generally westerly direction for about four and a half miles, draining the northern third of Grafton township and the southern part of Eaton before joining the East Branch at the northwestern corner of Grafton township.

(4) An un-named creek, known at present as the Bannister Ditch, for it has been improved as an artificial drainage channel, rises in the northeastern corner of Grafton township, flows due north for about three miles in Eaton township, parallel to the eastern boundary of the township, then flows west to the center of the township. At this point the stream swings northwest and flows in this direction until its course is deflected by Butternut Ridge so that it flows west along the south side of the ridge until it joins the East Branch at the Carlisle-Eaton boundary. The total length of the stream is about ten and three-quarter miles.

All the land, then, in the townships of Grafton, Eaton, Penfield (except the northeastern corner, which drains into the West Branch), eastern LaGrange, eastern Carlisle, and southeastern Elyria, drains into the East Branch of Black River either directly or by way of its tributaries.

From the confluence of the East and West Branches of Black River at Elyria, Black River flows generally north through Elyria township, just east of center, to the middle

of Sheffield township. It then flows west to empty into Lake Erie at the city of Lorain in Black River township. The length of Black River from the confluence to its mouth is about sixteen and a quarter miles. The two main tributaries of Black River proper are located to the east of the river:

(1) French Creek rises in the northeastern section of Ridgeville township and flows northwest through Avon township to the Avon-Sheffield boundary. It then flows west through Sheffield township to join Black River at the center of the township. It is about twelve and three-quarter miles long. Sugar Creek, a tributary of French Creek, rises at the southwestern corner of Avon township and flows northwest for about four and a quarter miles to unite with the latter a mile east of the center of Sheffield township.

(2) An un-named creek about seven miles long (known now as the Ridgeway Ditch, for it has been improved as an artificial drainage channel), rises in the southwestern part of Ridgeville and flows east along the south side of Sugar Ridge, then due north until its course is deflected to the west by Middle Ridge. The stream flows west for a mile on the south side of the ridge, then northwest to join Black River in the northeastern corner of Elyria township.

All the land, then, of the northern and western part of Ridgeville township, the southern half of Avon township

and the northeastern quarter of Black River township, drains into Black River proper either directly or by way of its tributaries.

The West Branch of Rocky River flows north from Medina county and enters Lorain county at the center of the southern boundary of Columbia township. It flows north for nine miles through the center of the township before leaving Lorain county at the northern boundary of Columbia township to continue its course north into Olmstead township, Cuyahoga county. Its main tributary in Lorain county is Plum Creek (a stream seven miles long located about two miles to the west of the river), which flows north through the western part of Columbia township roughly parallel to the main river. Plum Creek unites with the West Branch of Rocky River at the town of Olmstead Falls in Cuyahoga county. The land of Columbia township thus drains into the West Branch of Rocky River either directly or by way of its tributaries.

There are eight small streams which originate in the Lake Plains region and empty directly into Lake Erie without becoming a part of the major river systems. Brownhelm Creek, four miles long, and Quarry Creek, three and one-half miles long, both of which flow due north, are located between the Vermilion River and Beaver Creek, and drain the northeastern quarter of Brownhelm township. Martins Run, four and three-quarter miles long, is located halfway between

Beaver Creek and Black River and flows northwest roughly parallel to the Beaver-Little Creek system. It drains in all about four square miles of Black River township. Northeast of the Black River system, in Avon township, there are five un-named creeks, one and a half, one, five, two, and one-half miles long, respectively, from west to east. These streams are naturally shallow with extremely low gradients, except at the high bluff of the Lake Erie shoreline, and would have a negligible effect on the natural drainage of even their immediate bordering area; however, all five have been made suitable outlets for the artificial drainage system in Avon township.

c. Characteristics of the River Valleys

The rivers of Lorain county are post-glacial and youthful. In general, the valleys of the rivers, especially the small streams and tributaries, are V-shaped, shallow, narrow and relatively straight, having no appreciable bottomland along their margins. Due, however, to the general levelness of the land and the fact that in most places they are cutting deeply into unconsolidated glacial drift, the large rivers tend to meander and present an appearance of early maturity. In those places where the rivers meander the valleys are wide but retain distinct bluffs. The bottomlands along the rivers in such sections are wet, even to

the point of being swampy, as a result of the numerous springs and seepage at the base of the river bluffs. Along the West Branch of Black River, where the valley depth is between thirty and forty feet, there are five miles of bottomland, averaging about an eighth of a mile in width, in Brighton township, and seven and a half miles of bottomland, averaging one-fourth to one-half mile in width, extending from the northeastern part of Pittsfield township to the center of Carlisle township. Along Wellington Creek, from the point where the creek joins the West Branch of Black River, the bottomland, about an eighth of a mile wide, extends up-stream for about two miles. The valley of the creek is about forty feet deep in this section. There are three areas along the East Branch of Black River where bottomlands exist: (1) about four miles in the northeastern section of Penfield township and (2) about three miles in LaGrange township, averaging from one-eighth to one-fourth miles in width, and (3) about four miles in Carlisle township averaging about one-fourth mile in width. In these three sections the river valley is between ten and twenty feet deep. In Columbia township, along the West Branch of Rocky River, the bottomland extends for five miles, averaging about a half mile in width. The depth of the valley in this section is about fifty feet. The bottomland areas already mentioned are all part of the Till Plains area.

In the Lake Plains region, where the rivers have meandered through the lake clays, the glacial drift and even into the underlying bedrock of Ohio shale, there are extensive areas of bottomlands. Along the Vermilion River the bottomland, averaging one-fourth to one-half mile in width, extends for about four miles in Brownhelm township. The eleven and a half miles of bottomland along Black River, from the abandoned falls north of Elyria to the river's mouth, averages about one-fourth mile in width; however, in a few places where the stream is meandering, the width of the bottomland approaches a half mile. Along Beaver Creek, bottomland, about an eighth of a mile in width, extends from the mouth of the creek up-stream for about three miles.

In places where the rivers of Lorain county cut through bedrock the valleys are narrow and steep-sided. In general the streams begin cutting into rock from one to three miles south of the lake shore, since north of this point the gradient of the streams approaches the slope of the land. South of this point gorges are produced which become deeper upstream, since the gradient of the streams is less than the rise of the land to the south. The gorges are more prominent in the Lake Plains area, where the rivers are wider and have greater volume than in the Till Plains area. In Lorain county the valley of the Vermilion River is about twenty feet deep at the north where the river

crosses into Erie county. It deepens up-stream to about 140 feet at the point where the river enters Lorain county. Where Chance Creek joins the Vermilion River the Chance Creek valley is about 150 feet deep. The steep-sided, narrow gorge produced in this vicinity by Chance Creek and the Vermilion River has been cut through the glacial drift and Bedford Shale into the Ohio shale. The valley of Beaver Creek which is about twenty feet deep at the mouth increases to sixty feet in depth, four and a half miles up-stream. The valleys of both Beaver Creek and its tributary Little Creek have been cut through the lake clay and the glacial drift into the Ohio shales. The valley of Black River proper increases in depth from about twenty feet at the mouth to ninety feet ten miles up-stream. From the point where French Creek joins Black River, south to the confluence of the East and West Branches, the Black River valley has been cut through the lake clays, the glacial drift and into the Ohio shales. South of the confluence the bed rock nearest the surface is the Berea sandstone. The sandstone has been eroded back about a quarter of a mile to the falls of the East and West Branches of Black River at Elyria. These falls, which are about forty feet in height, are the only large ones in the county. Above the falls to the south, the valleys of the East and West Branches of Black River are about forty feet deep.

The stream valleys of the Till Plains area in Lorain county have been cut entirely into glacial drift with about four exceptions:

(1) One mile and a half of the valley of the East Fork of the Vermilion River, before the river leaves the county, has been cut through the drift into the Ohio shales. The valley is about eighty feet deep.

(2) From the point where Elk Creek joins the West Branch of Black River, south toward the source, the valley of Elk Creek has been cut through the drift into the Berea sandstone. This portion of the valley is forty feet deep and about a mile long.

(3) Extending north from the point where Swamp Creek empties into the East Branch of Black River, about a half mile of the valley of the East Branch has been cut through the drift into the Berea sandstone.

(4) The valley of the West Branch of Rocky River is, in Lorain county, about fifty feet deep. North of a point a mile and a half south of the Columbia township-Cuyahoga county boundary, it has been cut through the drift into the Berea sandstone.[1.]

Figure 4 shows in profile the slope of the West

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1. E. H. Wenberg, The Paleozoic Stratigraphy of Lorain County, Ohio, Masters Thesis, Oberlin College, 1938, Plates I and II.

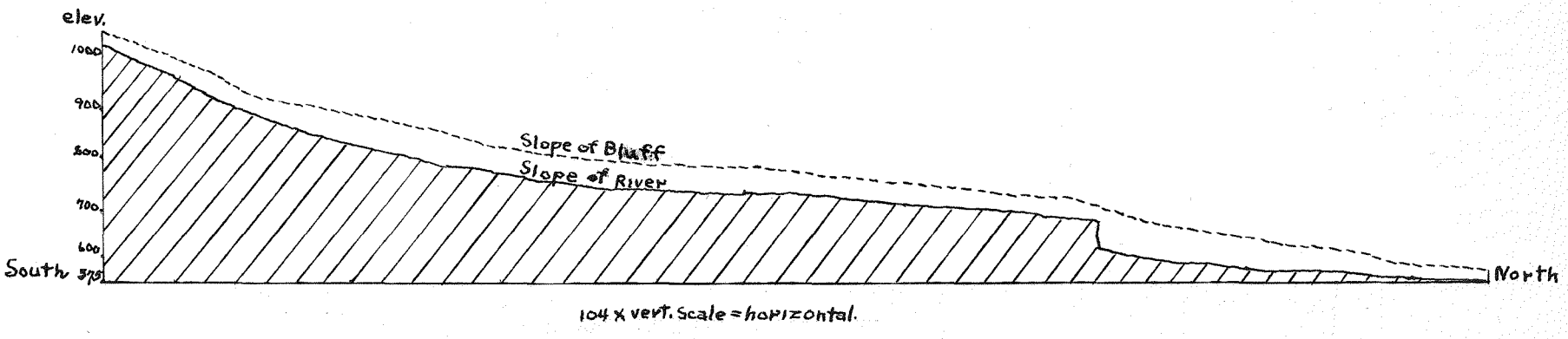


Figure 4. Profile: The West Branch of Black River and Black River Proper, and the Bluffs Along the River

Branch of Black River and Black River proper from the source on the Defiance moraine in the southwestern corner of Rochester township, north to the river's mouth at Lorain, along with the slope of the land along the river's bluffs. The profiles of the other rivers which flow from the Defiance moraine, north, across the Till Plains and Lake Plains areas, to empty into Lake Erie, would be similar. The average slope of the West Branch of Black River, in the region of the Defiance moraine, is about 15.4 feet per mile or 0.29 per cent. As the river crosses the Till Plains region and enters the Lake Plains area, its slope decreases to about 3.6 feet per mile or 0.07 per cent before reaching the falls at Elyria. Below the "forty-foot" falls, the slope of Black River is about 3.4 feet per mile or 0.06 per cent. In the fifty-three miles of its course the river drops 427 feet to reach its base-level in Lake Erie. The average slope of the river is 8.1 feet per mile or 0.15 per cent. The average slope of the county from south to north, a lineal distance of about sixteen miles, is about twn and a half times the average slope of the river which, cutting into the land, meanders a distance of fifty-three miles before reaching the lake.

In general, in the Till Plains area, especially in the region of the Defiance moraine, the streams are still in the process of degrading the land. In the Lake Plains

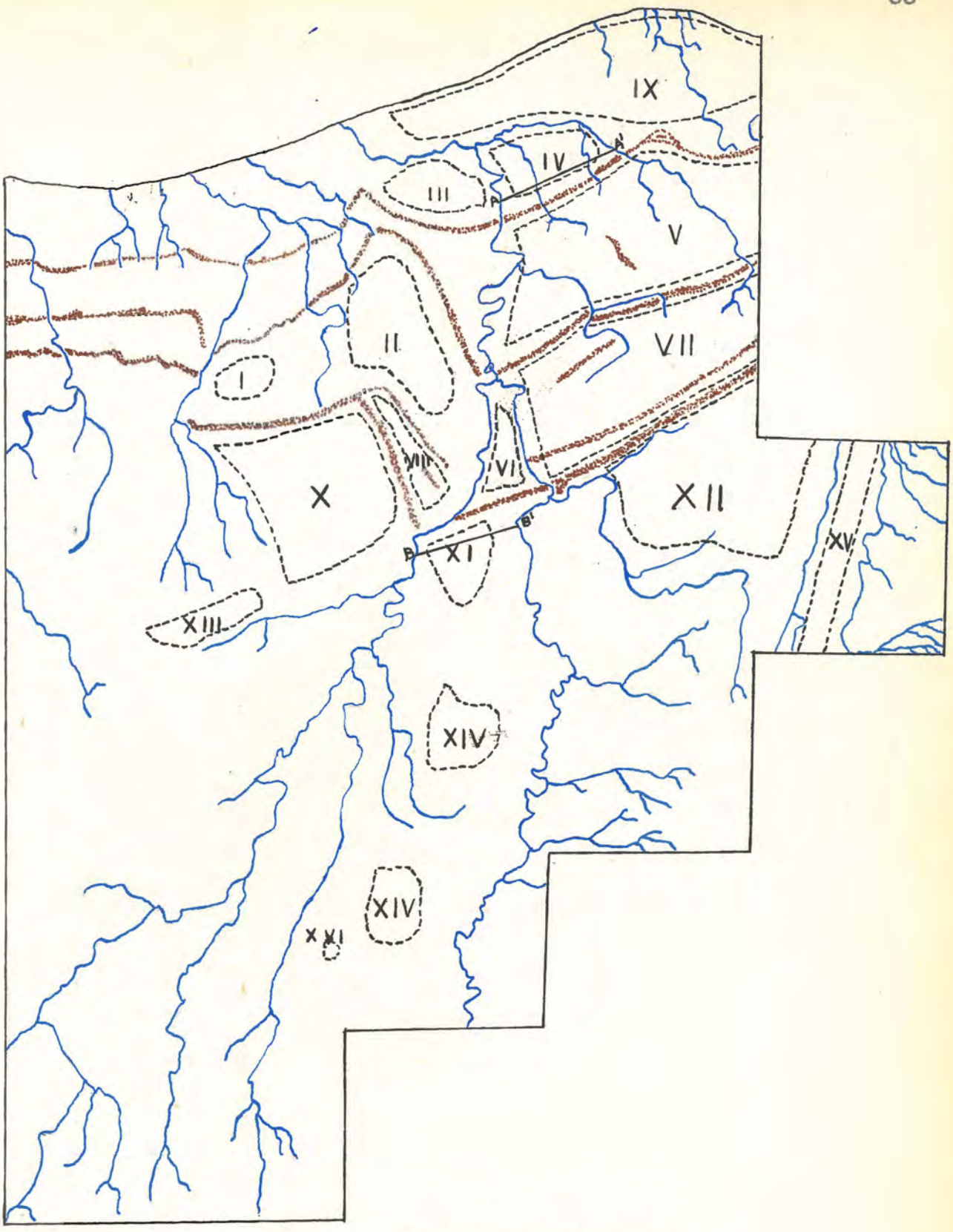
region, where the land is relatively flat and the streams approach or have reached base-level (the level of Lake Erie), the streams now have little cutting power and are in the process of depositing sediment (aggradation).

d. Areas of Poor Natural Drainage

Figure 5 shows the location of the areas of poor natural drainage in Lorain county. These areas lie between the natural watersheds of major rivers or streams (interstream areas). The land of a typical interstream area is extremely level. During periods of heavy rainfall, water tends to accumulate in the area, especially in the regions farthest from the natural drainage channels. All natural drainage of the area must be gravitational, since the land does not slope sufficiently to afford much surface run-off into the natural drainage channels. As a result, such an area requires artificial draining. Figure 6 shows two interstream areas in cross-section: Area IV in the Lake Plains region and Area XI in the Till Plains region.

The majority of the poorly drained areas are in the very level Lake Plains region where the presence of the beach ridges have further hindered natural drainage to the north:

Area I: In Amherst township, between North Ridge and Middle Ridge, there are about two



Approximate Scale 1:250,000

Figure 5. Areas of Poor Natural Drainage, Lorain County

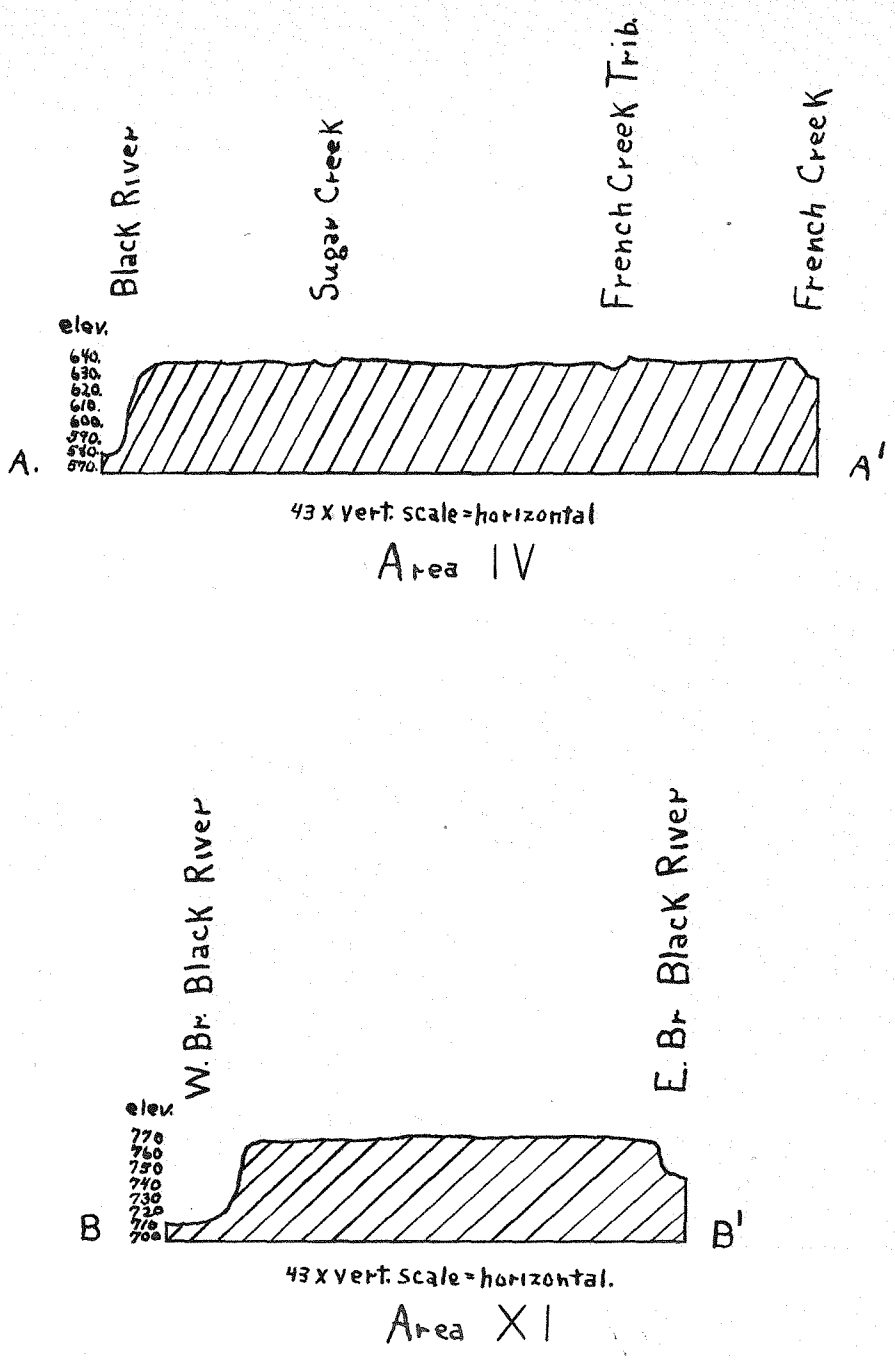


Figure 6. Interstream Areas in Cross-section

and a half square miles of poorly drained land between Beaver Creek and the headwaters of Little Creek.

Area II: Between the Beaver Creek system and Black River, there is a poorly drained area of about six square miles located north of Butternut Ridge and bounded on the northwest and northeast by Middle Ridge. The area extends from the eastern part of Amherst township to the northwestern part of Elyria township.

Area III: Between Martins Run and Black River proper, north of North Ridge, there is a poorly drained area of about four square miles.

Area IV: North of North Ridge between Black River and French Creek there are about four square miles of poorly drained land.

Area V: In Lorain county, between Middle Ridge and North Ridge, east of Black River, the entire glacial Lake Whittlesey plain, except for Rocky Ridge and several "bars" of sand and gravel, is very poorly drained despite the fact that the upper course of French Creek and the stream which has become the Ridgeway ditch cross the plain.

The area is so level that about a half mile east of French Creek, in the southeastern part of Avon township, a swamp at least a half mile square developed on the plain proper. In all there are about sixteen square miles of poorly drained land in this section of the Lake Whittlesey plain.

Area VI: North of Butternut Ridge, between the East and West Branches of Black River there is a level section about one and a half square miles in area which has poor natural drainage.

Area VII: East of the East Branch of Black River, the glacial Lake Maumee plain, like the Lake Whittlesey plain, is poorly drained except for Chestnut and Sugar Ridges. There are in all about fourteen square miles of poorly drained land in this portion of the Lake Maumee plain. The band of land about a half mile wide between Butternut Ridge and Chestnut Ridge has extremely poor natural drainage since there are no natural streams crossing Chestnut Ridge,

and the water settling between the two ridges produced numerous swamps.

Area VIII: West of the West Branch of Black River, between Butternut Ridge and Murray Ridge there are about one and a half square miles of poorly drained land. The impounding of water in this area caused a large swamp to develop west of Murray Ridge.

Area IX: North of North Ridge, northeast of Black River and French Creek, the glacial Lake Warren plain has poor natural drainage. The levelness of the plain does not afford good natural drainage into Lake Erie, and the five small natural streams in the area are incapable of relieving the area of excess surface water. This part of the plain consists of about twenty square miles of poorly drained land.

Although the Till Plains area of Lorain county has somewhat better drainage than the Lake Plains area, there are a number of rather level interstream areas in the Till Plains where the drainage is poor;

Area X: Between the Beaver Creek system and

West Branch of Black River, south of Butternut Ridge in Amherst township and west of the same ridge in Elyria and Carlisle townships, there is an area of about six square miles of poorly drained land which extends from the ridge into the northeastern part of Russia township.

Area XI: Between the East and West Branches of Black River, just south of Butternut Ridge in Carlisle township, there is about one square mile of poorly drained land.

Area XII: Between the stream which is now the Bannister Ditch and Plum Creek (Columbia township), south of Butternut Ridge, there is a poorly drained area of about ten square miles.

Area XIII: In Russia township, south of the headwaters of Beaver Creek and north of Plum Creek, there are about two square miles of poorly drained land.

Area XIV: Between the watersheds of Wellington and Elk Creeks to the west and the East Branch of Black River to the east there is a level upland area of about two square miles in the southeastern part of LaGrange

township, and a similar area of about one and a half square miles in the northwestern part of Penfield township. Both areas are poorly drained.

Area XV: In Columbia township, the interstream area between Plum Creek and the West Branch of Rocky River consists of about six square miles of poorly drained land.

Area XVI: In the east central portion of Wellington township, near the Wellington-Penfield boundary, an upland swamp of from fifty to seventy-five acres developed between the tributaries of Wellington Creek.

Besides the level, poorly drained interstream areas of the Till Plains section, there are a number of "kettle-holes" in the northwestern part (Henrietta and Camden townships) which with the passage of time have become bogs. One, about three miles southwest of Kipton, Camden township, is only partially filled with peat and still has a pond at the center. Through artificial drainage the water level of many of the bogs has been lowered and most of the swamps of the county have been drained to a point where they are now suitable for cultivation.

3. Soil

Ohio lies in the region of the Gray-brown Podzolic soils, which are pedalfers or "humid" soils that have developed under a deciduous forest vegetation in a humid temperature climate.[1] The state of Ohio has been divided into six major areas based on the character of the material from which the soils were derived (See fig. 7):

Area I: Glacial limestone soils

Area II: Glacial sandstone and shale soils

Area III: Soils of the glacial lake region of northwestern Ohio

Area IV: Soils of the glacial lake region of northeastern Ohio

Area V: Residual limestone and shale soils

Area VI: Residual sandstone and shale soils[2]

The Lake Plains region of Lorain county lies in Area IV, the rest of the county in Area II. Plate I shows the main types and distribution of the soils of the county.

a. Soil Types

In the Lake Plains area the ridges are composed

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1. Soils and Men, Yearbook of Agriculture, 1938, U. S. Dept. of Agric., U. S. Gov., Print. Off., Washington, 1938, p. 1033.

2. G. W. Conrey, A. H. Paschall and E. M. Burrage, A Key to the Soils of Ohio, Special Circular No. 44, Ohio Agric. Exp. Sta., Wooster, O., 1937, p. 3.

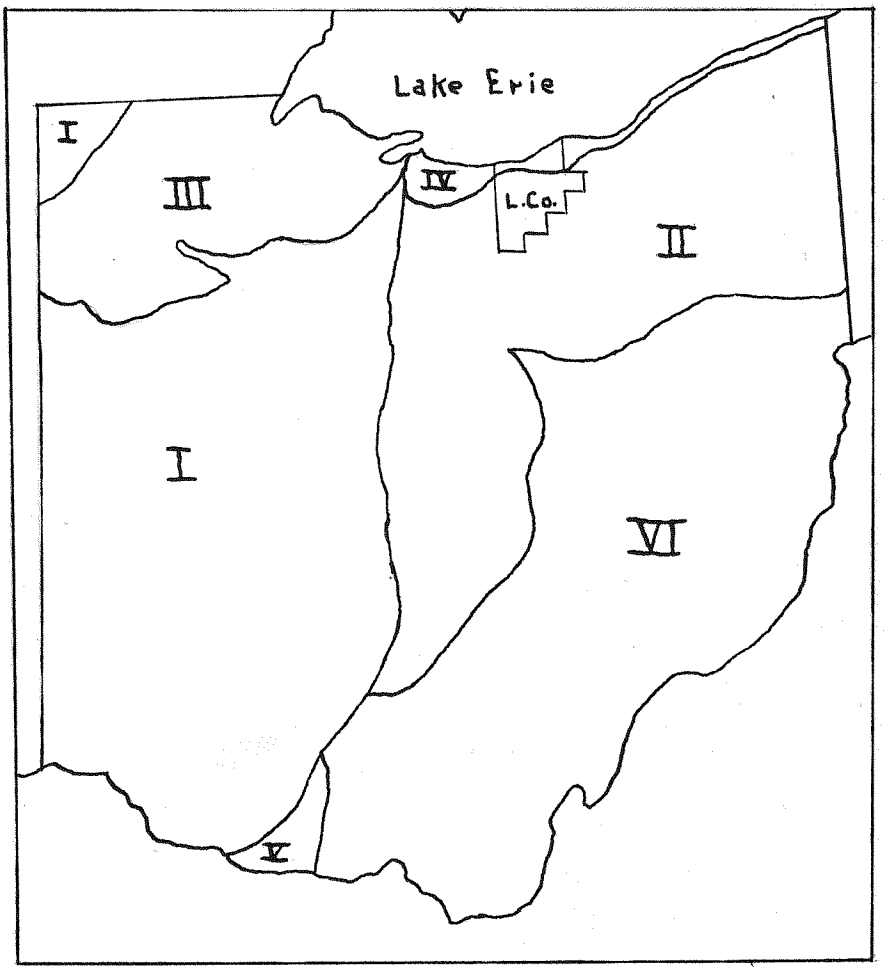

Figure 7. Soil Areas of Ohio

chiefly of Chenango Gravelly loam, or Berrien or Plainfield fine sand, all of which have good natural drainage. Bordering the ridges in many places where swamps had developed there are small areas of organic soil (muck) which developed under very poor natural drainage. The lake bottom soils which occupy the level to gently sloping areas of the lake plains are composed of Caneadea soils: loam, clay loam and silty clay loam; and Lorain soils: clay loam and silty clay, plus a few small areas of Painesville fine sandy loam. The Caneadea soils are light colored, heavy and have poor natural drainage. The few areas of Lorain soils are dark colored and have very poor natural drainage. The Painesville soil has fair to good drainage.[1.]

The dominant soils of the Till Plains and Appalachian Plateau areas of Lorain county are Mahoning silt loam, Ellsworth silt loam, and Trumbull silt loam, heavy subsoil phase. The Mahoning soil, which occupies the most extensive area, is located in regions where the land is gently undulating. "It is characterized by a brownish, gray heavy silt loam surface to about 7 inches underlain by a mottled yellowish brown and yellowish gray light silty clay loam to 30 or 36 inches. The underlying glacial till is a heavy silty clay loam to silty clay, moderately calcareous below 36 to

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1. K. Lindeman, op. cit., p. 2, and personal correspondence with G. W. Conrey.

40 inches."[1.] The Mahoning soil has fair surface drainage and very poor under-drainage.

The Ellsworth soil occupies the gently rolling areas. The surface soil is light brown. Below sixteen inches the subsoil is yellowish-brown, mottled with gray. The subsoil is very heavy and impervious; hence it has imperfect under-drainage. On the whole, the Ellsworth has somewhat better drainage than the Mahoning.[2.]

The Trumbull soil, gray in the surface soil and highly mottled in the subsoil, occupies the level to depressed areas of the Till Plains section. Both the surface drainage and the under-drainage of this soil are very poor.[3.]

In the northwestern part of the Till Plains area where the bedrock (Berea sandstone) is near the surface, the shallow till is composed of Lordstown silt loam. The color of the surface soil is brown, of the subsoil, yellowish-brown. Both the surface soil and the subsoil have good natural drainage.

In the region of the Defiance moraine, at the southern boundary of Lorain county, the soil is composed of Rittman silt loam. This soil is light brown to sixteen inches.

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1. Personal correspondence with G. W. Conrey.
2. Ibid.
3. Ibid.

Below sixteen inches the subsoil is pale-yellowish-brown mottled with gray. The drainage of both the surface soil and the subsoil is fair.[1.]

In localized areas of the Till Plains region where swamps and bogs have existed, there are areas of organic soils (peat or muck) which have poor natural drainage.

In both the Lake Plains and Till Plains areas, along the rivers, the bottomland soils are for the most part wet due to the amount of seepage and springs at the base of the river bluffs.

b. Soil-Drainage Relationships

The few regions of Lorain county where the soils have sufficient natural drainage for agriculture and do not need artificial draining are located:

(1) along the beach ridges in the Lake Plains section.

(2) along the bluffs overlooking the river valleys and the lake shore.

(3) in the areas situated on the sandstone bedrock in the northwestern part of the Till Plains section.

(4) in the region of the Defiance moraine.

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1. K. Lindeman, op. cit., p. 2, and G. W. Conrey, et al., op. cit., p. 16.

(5) possibly in the localized rolling areas of the Till Plains, and in the Appalachian Plateau, where the Ellsworth soil is located.

In general, the soils of the Till Plains section have somewhat better natural drainage than the muck soils and heavy lake bottom soils of the Lake Plains section which need artificial draining. In the Till Plains section, besides the organic soils, the soil most in need of artificial draining is the Trumbull. Both its surface soil and subsoil have poor natural drainage due to the fact that this silt loam developed in level interstream areas. Not only the "heavy" subsoil, but the surface soil as well, developed poor structure due to the excess water which tends to accumulate in the region during winter, spring and summer from the many cyclonic and convectional summer storms. The Mahoning soil also needs artificial draining, since its subsoil has very poor natural drainage. Artificial draining would be beneficial to the Ellsworth soil, too, since its subsoil has imperfect underdrainage.

Draining of the bottomland soils for agricultural purposes is impractical, since these soils are constantly receiving moisture from the seepage at the base of the river bluffs and from numerous springs. At best, these soils are useful as pastureland.

4. Natural Vegetation

The land of Lorain county, according to the histories of the region, was covered with a dense forest when the first white men settled the area. James Smith described the region as follows:

> "The timber is black-oak, walnut, hickory, cherry, black-ash, water-ash, buckeye, black-locust, sugar-tree and elm: there is also some land, though comparatively, but small, where the timber is chiefly white-oak or beech -- this may be called third rate. In the bottoms, and also many places in the upland there is a large quantity of wild apple, plum, and red and black haw trees. It appeared well watered, and plenty of meadow ground, intermixed with upland, but no large prairies or glades, that I saw or heard of . . . . About the falls (ridges) is thin chestnut lands. . ."[1.]

The presence of the forest resulted in a deep accumulation of vegetable mold producing a marked fertility in the resulting soil. The forest also served to absorb much of the water from the soil and regulate the amount of surface run-off.

By 1853 more than forty per cent of the land of Lorain county had been cleared for agriculture.[2.] Today, Lorain county has left but 23,683 acres of woodland or 7.4 per cent of the total land area. (See Plate II) The climax

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1. J. Smith, op. cit., p. 17.

2. K. Lindeman, op. cit., p. 7.

type for the region, Beech-Maple is still the most important, occupying 11,096 acres or forty-seven per cent of the wooded area. Some of the present woods in the county were once Beech-Maple but as a result of destructive cutting methods they are now an entirely different type. The Elm-Ash-Soft Maple type, an indicator of rather poorly drained soils, occupies 9,314 acres or thirty-nine per cent of the wooded area. This type has been encouraged by the faulty cutting methods and has gained at the expense of the Beech-Maple and Oak-Hickory types. The Oak-Hickory now occupies only 2,308 acres or 9.7 per cent of the wooded area, including not only the upland oak stands but also the pin oak and swamp white oak stands found in poorly drained regions. Since most of the streams in the county have relatively steep banks, the Flood-Plain type, found mostly in narrow strips in the bottomlands along some of the wider river beds, cover only 920 acres or 3.9 per cent of the woodland.[1.]

With the removal of the forests the poor natural drainage of the land in Lorain county was accentuated. The amount of surface run-off water was increased, adding to the burden of the natural drainage channels. "Sheet erosion" resulting from the action of the surface run-off water causes the silting up of the streams, and decreases their drainage efficiency.

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1. K. Lindeman, op. cit., pp. 14-18.

Part II: The Development of Artificial Drainage in Lorain County

A. Historical Background

1. Factors Leading to Artificial Drainage

Permanent settlement of the land of Lorain county began in 1807 after the region had been surveyed for the Connecticut Land Company as part of the Western Reserve.[1] The need for artificial drainage was recognized by the settlers early in the county's history. The most valuable lands of the county were located upon the well drained beach ridges, along the well drained bluffs overlooking the rivers which made natural pathways through the woods and provided water-power, and along the well drained bluffs overlooking the lake shore. These areas were settled first. As the lands were cleared, settlement encroached upon the poorly drained areas. There are many references in the various histories of Lorain county to the "level, wet land" and the difficulty of cultivating the undrained soil.

Communication between the various settlements was impeded by the swamps which existed in the Lake and Till Plains sections. In the northern part of the county the main roads were made along the ridges. South of the Lake Plains,

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1. See C. E. Sherman, Original Ohio Land Subdivisions, Vol. III, Final Report, Ohio Cooperative Topographic Survey, Press of the Ohio State Reformatory, 1925, pp. 79-88.

the main roads follow a rectangular pattern along the lines of the original survey of the area, except where rivers and swamps caused a variation from the general pattern. For example, due to the presence of the Wellington swamp ". . . . little was done upon the Penfield and Wellington road for many years, the swamp in the latter township remaining a place to be dreaded at all times of the year, and nearly, if not quite impassable during the wet season."[1.]

The early settlers suffered greatly from disease, much of which, no doubt, was brought on by lack of sanitation and poor drainage conditions.[2.] Along the rivers, especially at the mouth of Black River, were marsh lands that were infested with disease. Charleston (now Lorain) was unable to cope with the malaria and typhoid cases which occurred in the hot summer months.[3.]

2. Early Attempts at Artificial Drainage

Although there are no written records concerning

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1. History of Lorain County, Williams Bros., Philadelphia, 1879, p. 304.

2. For example: In 1811, four years after settlement began, the small colony in Columbia township suffered considerably. "A fever prevailed extensively resulting in the death of nine members of the little community. . . Whole families were sick at the same time and there were not enough in health to attend the sick." Ibid., p. 155.

3. G. F. Wright, A Standard History of Lorain County, Ohio, Vol. I, Lewis Publishing Co., Chicago and New York, 1916, p. 88.

artificial drainage projects in Lorain county before 1865, drainage ditches were constructed by individuals or groups of individuals on their own farm lands before that year. In the early petitions (1865-1880) for artificial drainage projects under county supervision, there are numerous references to following the line of a previously constructed ditch. It seems more than likely that beginnings in artificial drainage had been made in the county by 1850, for it was during the 1840's and 1850's that many German immigrants settled in Lorain county. Their contemporaries thought highly of them, admiring them for their sturdiness, their frugality, their thrift and their "splended old farms".[1.] It seems logical that their notable success as farmers would be due in part to their improvement of the land by artificial drainage.

At best, the attempts of individual farmers or small groups of land owners to drain their land were inadequate, for they lacked the technical skill, they could drain only lands with a natural outlet, and they fell into controversies over property and water rights. The burden of the labor and cost of draining the land was carried by a few land owners without regard for the extension of benefits from their projects to other lands in the watershed. The farmers were not able to cope with these problems as individuals or small groups. It became evident that in most

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1. Wms. Bros., op. cit., pp. 210, 232, 273.

cases satisfactory results could be obtained only by cooperative development on a larger scale.

3. The Drainage Unit

In Ohio, the political unit which handles artificial drainage is the county, subject to the laws of the State. The first general drainage law of Ohio was passed on February 8, 1847. As problems and issues concerning artificial drainage arose, other such laws were passed and amended from time to time until 1871, when an act was passed on April 12th which set the standards and procedure for establishing ditches, drains and watercourses within the individual counties. This law superseded all earlier county ditch laws and remained in effect until 1919, when on June 19th, an act was passed which codified all the ditch laws of the state and repealed the earlier laws without changing the general character of the drainage enterprises.[1 & 2.]

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1. Drainage: Ohio, 14th Census of the U. S., 1920, p. 5.
2. See Appendix for Legislature and Procedure of Establishing Ditches, Drains and Watercourses.

B. The Pattern of Artificial Drainage

1. Selected Areas

The pattern of the artificial drainage enterprises in Lorain county can be interpreted by a study of three selected areas: (a) the Lake Warren plain northeast of French Creek, Avon township, (b) the inter-ridge Lake Plains area between Black River and French Creek, and (c) the Till Plains - Appalachian Plateau area of Columbia township.

a. The Lake Warren Plain, Avon Township

Plate III shows the location of the ditches, drains, and watercourses of the Lake Warren plain in Avon township. This section is part of Area IX of the areas of poor natural drainage.[1] The artificial drainage pattern of this area under county auspices was begun in 1870. In that year, in the northwestern part of the area, the source of the westernmost natural stream which flows north into Lake Erie was cleaned and extended due east (south of Webber Road) for a mile through an "old" ditch. Four north-south laterals were constructed from the north side of the Powdermaker Road[2] to

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1. See fig. 5.

2. The Powdermaker Road is the first east-west road north of North Ridge.

the re-cleaned ditch. This project was the beginning of the Powdermaker system which now drains about five square miles of land, the greater portion of the eastern half of this area.

Between 1870 and 1880 the channels of the three natural streams to the east of the Powdermaker system were "cleaned" and the north-south laterals as far south as the Powdermaker Road were constructed. In the same period a ditch about a mile in length was constructed to the lake shore, parallel to the western boundary of Avon township. About 1871 the first ditch in the area to drain into French Creek was constructed. It extends north from the road along French Creek for about a half mile, parallel to the east side of Moore Road[1]. then crosses the road and runs south of east to drain into French Creek.

Between 1880 and 1890 many of the existing ditches were re-cleaned, deepened and widened. This procedure was necessary since many of the first ditches were too shallow and narrow to accommodate the heavy volume of water in "winter, spring and early summer" and became overloaded with silt. A new north-south ditch was constructed, parallel to the western boundary of the township. It extends for three-quarters of a mile from the south side of the New York, Chicago and St. Louis Railroad, south to empty into French Creek

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1. Moore Road is the second north-south road east of the western boundary of the township.

just west of the Lake Shore Electric Railroad. At the same time, about a half mile west of Moore Road, the north-south lateral which runs from the New York, Chicago and St. Louis Railroad south, then southeast, about a mile, to join the diagonal ditch just before the latter empties into French Creek was constructed.

The drainage work between 1890 and 1900 consisted mostly of the re-cleaning of the previously constructed ditches and the construction of a few north-south laterals to the four main systems which have natural outlets to Lake Erie. All these laterals were located north of the Powdermaker Road. In this period, however, artificial drainage work began in the southeastern portion of the area, east of the Lear Nagle Road[1] with the construction of a ditch, running north from the Powdermaker Road for a mile, then northeast and east to empty into Porter Creek just before the creek enters Cuyahoga county. This enterprise was the beginning of the Gifford system.

Between 1900 and 1910, many of the ditches were re-cleaned and most of the north-south laterals of the main ditch systems were extended south of the Powdermaker Road to their present limits. Four of these laterals were extended south across North Ridge to help drain off the waters which

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1. The Lear Nagle Road is the first north-south road east of the eastern boundary of the county.

tended to become impounded on the south side of the ridge. It was in this period that branches and laterals, emptying into the "mains", were constructed to the east and west of the major artificial drainage systems to drain the land lying between the major systems in the southern part of the area.

During the period between 1910 and 1920, many of the branches, laterals and portions of the main ditches were re-cleaned, and several east-west laterals with north-south branches were constructed in the southern part of the area. These tied the major systems together, producing a rather efficient network of artificial drainage ditches in the southern part of the area.

All the drainage enterprises of the area were open ditches up to 1920. Between 1920 and 1922 a few tile drains were constructed as new enterprises. Two, extending from the lake shore for a mile to the south, are located in the northeastern part of the section, east of the easternmost natural stream that empties directly into Lake Erie. A third, of about the same length, was constructed to carry off the excess water in the region between the easternmost natural stream and the Jacox Road.[1] A fourth, about a third of a mile long, located between the third and fourth natural streams

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1. The Jacox Road is the second north-south road east of the eastern boundary of Avon Township.

west of the western boundary of the township, runs from the north side of the Lake Shore Electric Railroad to the lake. To the west of this drain, but in the same vicinity, there is a shorter drain, about an eighth of a mile in length, which runs from the north side of the Lake Road[1]. to the lake. Also in this period a few of the previously constructed ditches were "enclosed".

Since 1920 a few branches have been added to the general network of the drainage systems in the southern part of the area but most of the drainage work has consisted of re-cleaning ditches and repairing a few tile outlets.

In general, the pattern of artificial drainage of the Lake Warren plain, Avon township, developed in five steps:

(1) The deepening of the channels and the extending of the sources of the natural streams.

(2) The construction of north-south laterals to the south of the main streams as far south as the Powdermaker Road.

(3) The extension and construction of all laterals south to French Creek and North Ridge, four laterals cutting through the ridge.

(4) The construction of laterals and branches to the east and west of the major ditch systems

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1. The Lake Road is U. S. highway No. 6, State highway No. 2.

to drain the inter-drainage areas.

(5) The tying together of major artificial drainage systems at the south by other laterals and branches, and the construction of separate tile drains between the major drainage systems to help drain the area from the lake shore inland, a distance of about one mile.

All the land of the Lake Warren Plain, Avon township, drains north directly into Lake Erie, mostly by way of the artificial drainage channels, except for two regions. About one square mile of land in the southwestern part of the area, south of the New York, Chicago and St. Louis Railroad, and west of the Moore Road, drains into French Creek. About one and two-thirds square miles of land in the southeastern part of the area, south of the New York, Chicago and St. Louis Railroad, and east of the Lear Nagle Road, drains to the west into Cuyahoga county by way of the Gifford-Porter Creek system.

The major artificial drainage systems of the area from west to east are (1) the Keihm-Blitz-Avins, (2) the Powdermaker, (3) the Titus-Pitts, (4) the Heider and (5) the Gable, and at the southeast (6) the Gifford.

Due to the levelness of the lake plain and the lack of topographic obstructions to the formation of the pattern of artificial drainage, the drainage channels were constructed

to conform with the rectangular pattern of the cultural features along the lines of the original survey of the area. The ditches follow section lines, farm lines, roads and railroads except in the few instances where they follow the slightly irregular paths of the natural watercourses. The rectangular pattern of drainage is most evident in the southern part of the area where the laterals and branches are numerous, this region being farthest from the lake with great need for artificial drainage. In the band of land extending from the lake shore inland for about a mile, the drainage pattern is linear. The ditches and drains running south-north suffice to drain this region without east-west branches or laterals.

b. The Inter-ridge Lake Plains Area

Plate IV shows the location of the ditches, drains and watercourses of the Lake Whittlesey and Lake Maumee plains between Black River and the French Creek drainage system, south of the northern boundaries of Elyria and Ridgeville townships and east of the north-south road that runs through the center of Ridgeville township. This section is part of Area V and Area VII of the areas of poor natural drainage (See fig. 5). The artificial drainage pattern, under county auspices, was begun in 1868. In that year, in the section north of Middle Ridge between Black River proper

and the natural watercourse which has become part of the Ridgeway system, the first ditch east of Black River was constructed by extending the source of a natural outlet into Black River south for about a mile to a point just north of Middle Ridge. From 1868 to 1870 two other drainage enterprises were begun in the area. About two-thirds of a mile east of the first ditch, another ditch was constructed from the natural outlet into Black River, south for about a mile parallel to the west side of Abbe Road,[1.] through Middle Ridge to a point just south of the ridge, then west for a third of a mile along the south side of Middle Ridge Road. That portion of the natural stream which runs east along the south side of Sugar Ridge was deepened and extended west for about a mile. The first lateral east of the western boundary of Ridgeville township was constructed from the extension of the natural stream south for a mile and a third to the north side of Chestnut Ridge. A few branches of this lateral were cut through the ridge to help drain off the swamp waters which existed in that section between Chestnut and Butternut ridges. The construction of the lateral with its branches and the deepening of a portion of the natural watercourse were the beginning of the Ridgeway system of artificial drainage.

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1. Abbe Road is the first north-south road east of Black River.

Between 1870 and 1880 development of the Ridgeway system continued. The natural stream, from the point where it cuts through Middle Ridge north to the point where it crosses the western boundary of Ridgeville, was deepened. The eastern tributary of the main stream, north of Middle Ridge, was deepened from the point where the tributary joins the main, east for about a half mile. About a mile to the north of the tributary a ditch was constructed from the northeastern corner of a rectangular tract of land bounded by roads, south and east to join the newly constructed Ridgeway "main". South of Sugar Ridge the Ridgeway system was increased by the construction of a north-south lateral running from the north side of Chestnut Ridge north along the western boundary of Ridgeville township, and by the construction of another lateral from the east end of Sugar Ridge south to Chestnut Ridge, two short branches of the lateral cutting through the ridge to drain a portion of the swamp lands between Chestnut and Butternut ridges. This eastern lateral was made by straightening and deepening a natural tributary to the main stream, and extending the tributary's source south through Chestnut Ridge.

In the same period, 1870-1880, artificial drainage was begun in the vicinity of Elyria, when the small stream which joins the East Branch of Black River just south of Middle Ridge was deepened from its outlet to the east as

far as Abbe Road. A lateral to the stream was constructed from a point about a quarter of a mile upstream south for a distance of about one mile. This lateral taps the headwaters of two rivulets, diverting the waters north to the larger stream. This project marked the beginning of the Diedrick system of artificial drainage. Another ditch which runs along the north side of Chestnut Ridge from Abbe Road west to the East Branch of Black River was constructed to remove the water running from the north side of the ridge. This ditch is an individual enterprise, not connected to any of the larger artificial drainage systems.

It was between 1870 and 1880 that the natural drainage of the region between Middle Ridge and the southern end of Rocky Ridge was diverted from the west to the east, then north, through the French Creek system. This was accomplished by deepening and grading the channel of the stream which flowed to the west, south of Rocky Ridge, so that from a point just west of Rocky Ridge the stream now flows east to join the French Creek artificial drainage system just east of the north-south road that runs through the center of Ridgeville township. From a point south of Rocky Ridge a ditch was constructed from the stream south for about a half mile then west for a half mile.

Between 1880 and 1890 many of the ditches constructed earlier were re-cleaned, deepened and widened. In

the southwestern section of the area between Chestnut and Butternut ridges a ditch, running from the south side of Chestnut Ridge south for about a quarter of a mile, then west to the East Branch of Black River was constructed to relieve the section of the waters that became impounded between the ridges. In the vicinity of Elyria the Diedrick system was extended by the construction of an east-west ditch extending for a half mile on either side of the south end of the first north-south lateral of the system. Another lateral about a half mile in length was constructed at right angles to the east end of the new ditch. The east end of the Diedrick main was extended south along the west side of Abbe Road to the north side of Chestnut Ridge.

In the same period, 1880-1890, the laterals to the Ridgeway main south of Sugar Ridge were constructed from the main as far south as Chestnut Ridge. Drainage of the area in Ridgeville township northeast of Rocky Ridge was begun with an extension of the French Creek system from Avon township into the area. Along the west side of Rocky Ridge a ditch about a mile long was constructed to drain south into the previously diverted stream which drains into the French Creek system.

Between 1890 and 1900 the Ridgeway system was completed to its present extent. Laterals and branches to the main laterals, in the region between Sugar Ridge and Chestnut

Ridge, were constructed, and branches were extended cutting through Chestnut Ridge to drain the area between Chestnut and Butternut Ridges. In the southeastern part of the area, between Chestnut and Butternut Ridges, an east-west branch was constructed to tie the Ridgeway system to the French Creek system. The French Creek system had been developed in the same manner as the Ridgeway to drain the western part of the Lake Whittlesey and Lake Maumee plains. The Ridgeway Main was cleaned and deepened from a point at the east end of Sugar Ridge to the place where the stream crosses through Middle Ridge and re-cleaned from here north to the outlet. This was necessary, for the stream, unable to cope with the added load of water and sediment coming from the region between Butternut Ridge and Sugar Ridge by way of the extended drainage system in that region, had become silted. Three laterals to the main were constructed in the area south of Middle Ridge and north of the Lake Shore and Michigan Southern Railroad to relieve the region just south of the ridge of the surplus water that tended to settle there in "winter, spring and early summer" due to the levelness of the region and the ridge barrier to the north. In the same area a ditch was dug along the south side of the ridge to drain east for about a mile before joining the French Creek system at the point where a lateral of the system cuts through the ridge just east of the north-south road

running through the center of Ridgeville township.

Most of the drainage work done in the Inter-ridge area between 1900 and 1910 consisted of re-cleaning parts of the various artificial drainage systems. In this period the Diedrick system was completed by the construction of the ditch which runs along the Elyria-Carlisle boundary from the west side of the road that runs along the east bluff of Black River, to the ditch running south along Abbe Road.

Between 1910 and 1920 some ditch re-cleaning and repairing work was done and the region between the Case Road[1] and Rocky Ridge was artificially drained. This was accomplished by the extension of the Sugar Creek system of Avon township south into the area as far south as the east-west natural watercourse located just south of Rocky Ridge. As a result this section drains to the north, with the exception of the rectangular portion of land that drains east into the Ridgeway system by way of the previously constructed lateral.

Since 1920 most of the artificial drainage work of the area has consisted of re-cleaning ditches. The greatest project was the re-cleaning of the entire Ridgeway system by the Civilian Conservation Corps, started January 4, 1937 and finished June 27, 1938. The Ridgeway system is

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1. The Case Road is the first road running north, east of the western boundary of Ridgeville township.

the second largest artificial drainage system in the county.[1] Consisting of about twenty-three miles of ditches, it is the sole outlet for about 4500 acres of valuable truck farming land. This project cost the land owners of the region $3,247.75 and the Federal government $38,383.87, a total of $41,631.62.

In general, the pattern of artificial drainage of the Inter-ridge area developed in four steps:

(1) The deepening and widening of the channels and the extending of the sources of the natural streams.

(2) The construction of north-south laterals to the south of the mains with a concentration of ditches between Butternut and Chestnut ridges and between Chestnut and Sugar ridges, the sections having the poorest natural drainage.

(3) The construction of other laterals and individual ditches to the east and to the west of the main artificial drainage systems to drain the lands lying between the major systems.

(4) The tying together of the Ridgeway and French

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1. The largest is the French Creek system which drains the entire Lake Whittlesey plain east of Rocky Ridge to the eastern boundary of the county and the eastern third of the Lake Maumee plain in Lorain county.

Creek systems in the region between Butternut and Chestnut ridges.

All that part of the Inter-ridge area west of the western boundary of Ridgeville township and south of Middle Ridge drains generally west into the East Branch of Black River by way of the artificial drainage channels. The land of the interstream section north of Middle Ridge, between Black River proper and the Ridgeway "main", drains generally north then west into Black River. South of Middle Ridge, the land between the western boundary of Ridgeville township and the north-south road that runs through the center of Ridgeville drains north by way of the Ridgeway system. The northeastern section of the area east of Rocky Ridge drains generally north and east into the French Creek system. North of Middle Ridge between the Ridgeway main at the west and Rocky Ridge at the east, there is a section about three square miles in area that is extremely level. Artificial drainage of this section has been accomplished by dividing the section into three drainage areas. The southwestern portion drains west into the Ridgeway system. The northern and central portion drains north into the Sugar Creek system. The east central portion, just west of Rocky Ridge, and the southern portion, between Middle Ridge and the southern end of Rocky Ridge, drains generally east into the French Creek system.

The general pattern of artificial drainage in the Inter-ridge area is rectangular. Most of the area is extremely level, and the cultural pattern of the area, like the cultural pattern of the Lake Warren plain in Avon township, was developed along the lines of the original survey of the area in a north-south and east-west direction. The rectangular pattern of drainage of the Inter-ridge area is most obvious in the level section between Chestnut and Sugar ridges. Butternut, Chestnut, Sugar and Middle ridges which run northeast-southwest, and Rocky Ridge which runs slightly west of north are obstructions to the general pattern. The ditches which bound the ridges generally parallel them, just as the main roads of the area run along the crests of the ridges. Since all the drainage of the area depends upon the natural streams for an outlet, the part these streams play in the drainage pattern is greater than the part the streams of the Lake Warren plain play in the drainage pattern of that area. As a result, there is a greater divergence from the general pattern of the Inter-ridge area, where the ditches follow the natural watercourses, than in the Lake Warren plain. This divergence is most evident along the Ridgeway "main".

c. Columbia Township

Plate V shows the location of the ditches, drains

and watercourses in Columbia township. This section includes Area XV and the eastern part of Area XII of the areas of poor natural drainage (See fig. 5). The artificial drainage pattern, under county auspices, was begun in 1872. In that year a ditch was constructed in the west central portion of the township near the western boundary of the township. It runs from a point about a half mile south of the east-west road running through Columbia Center north for about a mile, then west to the western boundary of Columbia township to cross into Eaton township, and drains into one of the laterals of the Bannister system, the most extensive system in Eaton township.

Between 1872 and 1880, to the north of the first ditch, just north of the Cleveland, Cincinnati, Chicago and St. Louis Railroad, a group of ditches was constructed as branches to an eastward extension of the Bannister system. In the same period, in the interstream area between Plum Creek and the West Branch of Rocky River, in the vicinity of Columbia Station, a ditch about a half mile in length was constructed to drain west into Plum Creek. To the west of Plum Creek in the northwestern section, another ditch was constructed from a point just east of Root Road[1]. to run northeast for a mile and a half, then generally east for a

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1. Root Road is the diagonal road which crosses the railroad at right angles.

half mile to empty into Plum Creek near the northern boundary of the township.

Between 1880 and 1890 the other main ditches in the northwestern section of the township were constructed to drain west into the Bannister system. In that period the channel of Plum Creek from the center east-west road was deepened for a distance of a mile toward the north. The three main laterals, two draining east and one draining north into the deepened portion of the creek, were constructed. Other drainage work of this period consisted of re-cleaning several of the earlier constructed ditches.

Between 1890 and 1900 all of the ditches draining west into the Bannister system were re-cleaned and their channels were increased in size. The decade, 1890-1900, marked the completion of the Plum Creek system south to the southern boundary of the township. The main channel of the natural watercourse was deepened, widened and straightened. A portion of the tributary of Plum Creek in the southwestern part of the township was cleaned and its course diverted in places to conform to the cultural pattern of the roads and farm lines. At the south a lateral was constructed, from the channel of the tributary east, to drain into Plum Creek. This lateral serves to drain off the headwaters of the tributary and drain part of the region lying between the two streams. Two laterals located to the west of the

tributary were extended west and south from it. The laterals located to the east of Plum Creek in the interstream area between the creek and the West Branch of Rocky River were constructed to extend east and south.

While the Plum Creek system was being completed, at the north of the township in the Plum Creek-Rocky River interstream area the ditch which parallels the north side of the railroad, and the north-south lateral which crosses the railroad were constructed to flow north and east to join the West Branch of Rocky River in Olmstead township, Cuyahoga county.

Between 1900 and 1910 the only artificial drainage work done in Columbia township consisted of the re-cleaning of a few ditches.

Between 1910 and 1920 two ditches were constructed. One, located to the west of Plum Creek, runs from the north side of the railroad, northeast, a distance of about a mile and a quarter, to empty into Plum Creek. The other, located in the interstream area between Plum Creek and the West Branch of Rocky River, is the only east-west ditch of the interstream area to drain into the West Branch within the township.

Since 1920 most of the artificial drainage work in Columbia township has consisted of re-cleaning the open ditches; however, in 1921 and 1922 some of the previously

constructed ditches in the Plum Creek system were enclosed by "tiling".

In general, the pattern of artificial drainage in Columbia township developed in four steps:

(1) The extension of the Bannister system of Avon township eastward into the western portion of Columbia township.

(2) The improvement of the natural watercourse of Plum Creek and the construction of laterals to the east and west of the creek near the center of the area.

(3) The improvement of Plum Creek south to the southern boundary of the county, and the construction of laterals to the west and southwest, to drain the interstream area between Plum Creek and the Bannister system of Eaton township, and to the east and southeast to drain the interstream area between Plum Creek and the West Branch of Rocky River.

(4) The construction of two laterals in the interstream area between Plum Creek and the West Branch of Rocky River to drain portions of the area into Rocky River.

There are no artificial drainage enterprises east of the West Branch of Rocky River, for in this section the

slope of the land is great enough to afford good drainage into the numerous tributaries of the West Branch. Most of the land of the interstream area between Plum Creek and the West Branch of Rocky River drains north and west into the Plum Creek system by way of the artificial drainage channels. It would be technologically impractical in most instances to drain this section to the east into the West Branch due to the presence of the steep bluffs and wide flood plain along the west side of the river. The land between the watershed of the Bannister drainage system and Plum Creek drains north and east into the Plum Creek system by way of its artificial drainage channels.

The artificial drainage enterprises of Columbia township for the most part present a dendritic pattern. This pattern is most evident in the Plum Creek system south of Columbia Station. Although an area of poor natural drainage, the Till Plains region of Columbia township has somewhat better natural drainage than the very level Lake Plains areas of Avon and Ridgeville townships, since the Till Plains area has greater natural slope than the Lake Plains areas. While it was necessary to construct a concentration of ditches in a rectangular pattern to drain the Lake Plains areas of Avon and Ridgeville townships, fewer ditches, less concentrated, but well placed along dendritic lines suffice to drain the Till Plains area of Columbia township.

2. The County

Plates VI - XXVI are contour maps of the twenty-one townships composing Lorain county showing the location of the ditches, drains and watercourses of the artificial drainage system (See Appendix). The first county drainage enterprise was completed in December, 1865. It consisted of constructing a ditch running southeast through the center of the swamp which existed on the west side of Murray Ridge, and deepening the natural outlet of the swamp to the West Branch of Black River. The ditch, about two miles long, parallels the west side of Murray Ridge.

In general, after the completion of the first ditch, the pattern of artificial drainage in Lorain county developed in five steps:

(1) The construction of ditches through the swamps of the county and the deepening of their natural outlets.[1.]

(2) The deepening, widening and straightening of the natural watercourses of the areas of poor natural drainage.[2.]

(3) The extension of the sources of the natural watercourses into their hinterlands.

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1. For location of swamps, see Organic Soil Areas, Plate I.

2. See fig. 5.

(4) The construction of laterals from the improved watercourses into the poorly drained interstream areas.

(5) The construction of other laterals and branches into the sections lying between the watersheds of the major artificial drainage systems, in some instances tying the artificial drainage systems together, to insure efficient drainage of all sections of the areas of poor natural drainage when the ditches and drains are properly maintained.

Most of the artificial drainage enterprises of Lorain county are located in the areas of poor natural drainage (See fig. 5). The greatest concentration is in the level Lake Plains region where the soils consist of poorly drained lake clays and where most of the forests have been removed from the land. (See Plates I and II). Most of the drainage enterprises in the Till Plains area are located toward the north, just south of the Butternut Ridge, in the eastern part of the county where the land is nearly level, where the soils are the very poorly drained Trumbull or poorly drained Mahoning, and where most of the forests have been removed.

Topographically, the number and extent of the drainage enterprises are inverse to the relief and slope of

the land. In the region of the Defiance moraine, in the southern part of the county, and in the southeastern section of Columbia township, regions where the land has the greatest slope of the county and is well drained and dissected by natural streams, there are no county ditches. In the gently rolling stream dissected portions of the Till Plains area there are few ditches. In the level to depressed interstream areas of this section, areas of poor natural drainage, many ditches have been constructed. In the level Lake Plains area most of the drainage enterprises are located in the eastern part. There the plain is widest, the land is extremely level, the streams are few, the interstream areas are extensive and the pronounced beach ridges impede the natural flow of water to the north. This part of the Lake Plains area contains the most extensive areas of poor natural drainage (See fig. 5). There are fewer ditches in the western part of the Lake Plains area. The plain there is narrow, the ridges are less pronounced, and the streams are more numerous. In that section there are no obvious areas of poor natural drainage. Most of the drainage enterprises in the western part of the Lake Plains area are merely improvements of the natural stream beds.

There is a direct correlation between soil type (See Plate I) and extent of artificial drainage. There are no artificial drainage enterprises located in the naturally

well drained Lordstown or fairly well drained Rittman and Ellsworth soils. The majority of the county ditches are located in the heavy, poorly drained lake clay soils, the muck and peat soils, and the poorly drained Mahoning and Trumbull soils, more being concentrated in the Trumbull in proportion to the extent of land area of this type than to the extent of the Mahoning.

The distribution and extent of artificial drainage enterprises is inverse to the distribution and extent of forests and woodlots over the county. The more forest-denuded a section has become, the greater the concentration of ditches. In the northeastern part of the county where the concentration of ditches is heaviest there are relatively few woodlots. In the southwestern part of the county where the drainage enterprises are fewest, there is the greatest concentration of woodlots.

Due to the general levelness of Lorain county and the methods of the original survey of the area, settlements and associated cultural features form a rectangular pattern in accordance with the points of the compass, except where topographic features, such as beach ridges and natural watercourses, cause a divergence from the pattern. The artificial drainage channels, except where natural watercourses have been improved and where they parallel the beach ridges, follow property, section and township lines. As a result,

they generally form a rectangular pattern. This pattern is most evident in the northeastern section of the county, in the Lake Plains region where most of the ditches do not follow natural watercourses. Where natural watercourses have been improved the drainage enterprises tend to form a dendritic pattern. This pattern of artificial drainage is most evident in the Till Plains region, especially in La-Grange and Columbia townships.

C. The Extent, Cost and Types of Artificial Drainage Enterprises

1. The Extent of Artificial Drainage

Of the 316,800 acres of land in Lorain county, about 118,042 acres, or 37.2 per cent, were swampy or subject to overflow before the land was artificially drained. Between 1865, when the first county drainage enterprise was completed, and 1920, when the first United States census of artificial drainage by counties was taken, 35.9 per cent of the land area of Lorain county was artificially drained by 753 miles of ditches and drains (See Table I). In 1920, 4,291 acres of land in Lorain county were classified as being swampy or subject to overflow and unfit for any crop.

Between 1920 and 1930 the lineal extent of ditches and drains was increased by 39.5 miles.[1] The land area artificially drained decreased, however, to 30.9 per cent, since many of the ditches established before 1920 had become silted. Maintenance costs during the 1920's were exorbitant. Most of the ditch petitions that were filed between 1926 and 1929 were dismissed by the county commissioners since "costs" of construction would be "greater than the benefits" received. In 1930, 3,655 acres of land in Lorain

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1. There probably is some duplication in the total length of ditches, since the reports of some enterprises do not show the portions of their ditches constructed earlier.

Table I: Lorain County Drainage Enterprises Classified by Condition and Use, Works and Capital Invested in 1920, 1930 and 1940

Land Area		1920	1930	1940
Approximate land area	Acres	318,880	318,080	316,800
Drainage enterprises	No.			434
Land in enterprises	Acres	113,716	97,928	173,586
Condition and Use of Land				
Land with drainage sufficient for normal crop	Acres		74,761	173,586
Land partially drained for partial crop	Acres		19,512	----
Land undrained unfit for any crop	Acres	4,281	3,655	----
Land Classified by Works				
Land drained by open ditches only	Acres	108,999	87,877	157,511
Length of these ditches	miles	703.6	718.6	1,113.5
Land drained by tile only	Acres	1,244	6,452	6,655
Length of these tile	miles	11.3	34.1	33.3
Land drained by open ditches and tile	Acres	3,518	3,599	9,420
Length of these ditches	miles	27.4	17.6	34.3
Length of these tile	miles	10.7	22.2	19.3

Table I (cont.)

Drainage Works		1920	1930	1940
Open ditches completed	miles	731.0	736.2	1,147.8
Tile drains completed	miles	22.0	56.2	52.6
Total	miles	753.0	792.5	1,200.4
Capital Invested				
Capital invested in these enterprises to Jan. 1.	$	456,376	763,683	695,088
Average cost per acre	$	4.01	7.80	4.00
Enterprises having open ditches only	$	393,914	473,470	457,241
Average cost per acre	$	3.61	5.39	2.90
Enterprises having tile only	$	22,627	170,444	167,147
Average cost per acre	$	18.19	26.42	25.12
Enterprises having open ditches and tile	$	39,835	119,769	70,700
Average cost per acre	$	11.32	33.28	7.50

Reference: 14th Census of the U. S., 1920, Drainage of Agricultural Lands

15th Census of the U. S., 1930, Drainage of Agricultural Lands

16th Census of the U. S., 1940, Drainage of Agricultural Lands

county were classified as being unfit for any crop. This was 626 acres less than in 1920.

The decade between 1930 and 1940 was one of great expansion in ditch construction and maintenance. During that period, the lineal extent of ditches and drains was increased by 407.9 miles to a total of 1200.4 miles in 1940. By that year, 54.8 per cent of the land area of Lorain county had been artificially drained. This was an increase of 23.9 per cent over 1930 or 18.9 per cent over 1920. In 1940, none of the land in Lorain county was classified as being unfit for any crop. The great expansion of drainage works in the 1930's was accomplished mostly through aid from the Federal government. Most of the drainage enterprises of this period were constructed between 1935 and 1938 by the Civilian Conservation Corps in Lorain county, the Federal government paying most of the costs of establishment.

Today, 129,800 acres of land in Lorain county are drained by natural watercourses or privately constructed ditches or tile lines. County and township ditches provide drainage for the remaining 187,000 acres.[1.]

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1. Annual Report of the Lorain County Engineer's Department, 1946, p. 17.

2. Capital Invested

Between 1865 and 1920, $456,376 had been invested in the Lorain county drainage enterprises. This amount covers only the cost of materials between 1865 and 1900, plus the cost of materials and some labor between 1900 and 1920. Before 1900, all the labor involved in the actual construction and maintenance of ditches was provided by the individual land owners, and the costs were not included in the recorded costs of construction. The practice of "letting contract" for ditch construction began just after the turn of the century; however, between 1900 and 1920 the land owners frequently contracted to do the work themselves, and the labor costs were not included in the overall costs of construction. Since 1920 most of the labor and machinery utilized in ditch construction is provided by commercial contractors, the costs being included in the costs of construction.

Between 1920 and 1930, $763,683 were spent for ditch construction and maintenance. Another $695,088 were spent between 1930 and 1940. The total amount spent for county artificial drainage projects, between 1865 and 1940 was $1,888,047.

3. Types of Artificial Drainage Enterprises

There are two types of artificial drainage in Lorain

county, the "open" ditch type and the "closed" tile drain type. The areas in drainage enterprises are classified as lands drained by open ditches only, lands drained by tile only, and lands drained by open ditches and tile.

Artificial drainage under county auspices before 1900 consisted mainly of the establishment of open ditches and the re-cleaning of open ditches and natural watercourses. The practice of establishing "closed" tile drains was begun about the turn of the century.[1.] Of the 22 miles of tile drains which were established by 1920, about half, or 11.3 miles, were in new drainage enterprises. The other half, or 10.7 miles, resulted from the "closing" of "old open ditches". Of the land area of Lorain county in drainage enterprises in 1920, about 96 per cent was drained by open ditches only, 1 per cent by tile drains only and 3.0 per cent by open ditches and tile.

In the 1920's the extent of tile drainage increased by 34.3 miles, of which 22.8 miles were in new drainage enterprises. The remaining 11.5 miles resulted from the closing of open ditches. Most of the "tiling" of the 1920's was done between 1920 and 1922 before the costs of tile and

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1. No doubt, tile drains were used before 1900 by individual farmers to drain their fields but there are no written records concerning the extent of this drainage. The outlets for such drains are the county ditches and drains and the natural watercourses of the region.

labor became prohibitive. In 1930, of the land area in drainage enterprises, about 90.0 per cent was drained by open ditches only, 6.5 per cent by tile drains only and 3.5 per cent by open ditches and tile.

Between 1930 and 1940 no new tiling or enclosing of ditches was done. Most of the tiling work of that period consisted of repairing already existing drains. In 1940, about 91.0 per cent of the land area in drainage enterprises was drained by open ditches only, 4.0 per cent by tile only and 5.0 per cent by open ditches and tile.

According to the Engineer's annual report for 1946, there are at present 102 miles of tile drains in Lorain county, an increase of 45.7 miles over the extent of tile drains in 1930. All of this increased length of tile drains resulted from the enclosing of already existing county drainage enterprises.

By 1940 all of the land of Lorain county had sufficient drainage, either natural or artificial, for the cultivation of some crop. Most of the drainage work in the county since 1940 has consisted of re-cleaning or enclosing previously constructed ditches.

4. Problems of Maintenance and Possible Future Development

The initial cost of constructing an open ditch

is much less than the cost of constructing a tile drain of equal length. In most cases, however, the closed drain is preferable to the open ditch. When properly constructed and cared for the closed drain may be considered permanent. Open ditches must be re-cleaned periodically if they are to function efficiently. They waste much valuable land, encourage erosion and weed distribution. Even with the best of care, an open ditch becomes silted after a time and will not function properly.

In general, the ditches of Lorain county are badly kept. The channels become choked with weeds. Often fences, which check the flow of water and encourage the deposition of sediment, are built across the channels. Too often the ditches become littered with bottles, cans and other types of debris. Some farmers have been known to use the ditches for sewage disposal. At present there seems to be no official way of enforcing proper maintenance of ditches. The engineer can act only upon petition and procedure according to the statutes. The health department acts only upon complaint, and has jurisdiction only when public health is jeopardized. Much could be done through the cooperation of all the individual land owners to maintain and keep the ditches in working order for much longer periods of time before re-cleaning would become necessary. They could refrain from using the ditches as dumping grounds.

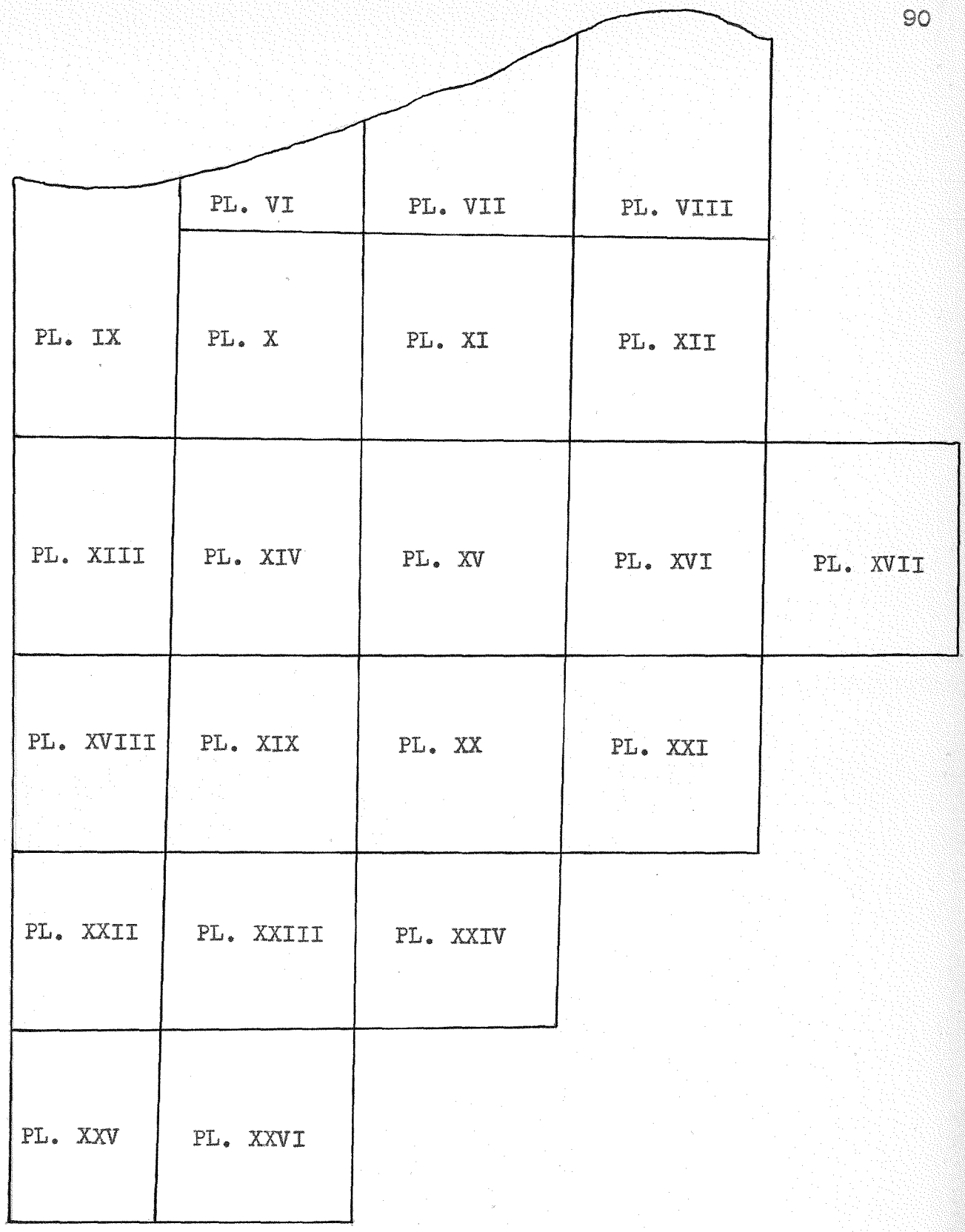
They could remove the weeds from the channels every fall and remove other obstructions to the flow of water, thus insuring maximum efficiency of the ditches at a minimum expense.

Much time and money could be saved in the construction and maintenance of ditches through the use of county-owned machinery operated by a county-employed crew. Before this could be done there would have to be a slight rewording of the statutes so that the engineer, at the discretion of the county commissioners, could either let contracts or employ county machinery. At present the Lorain county Sanitary Engineer is attempting to influence the state legislature to make such provisions. There is, of course, much opposition by contractors to such a change. In the interest of the public welfare, however, a change in the statutes seems advisable, for the ditches should be cleaned immediately when necessity warrants it. Too often, when other more profitable construction work is available, there are no bids offered for ditch construction, or bidding prices are at a prohibitive level.

It is not likely that any new county drainage enterprises will be constructed in Lorain county in the future. The costs of further draining of land that is now sufficiently drained for some crop would exceed the benefits that might be gained. Most of the drainage work in the future

will consist chiefly of the re-cleaning and repairing of already existing ditches, drains and watercourses. If the price of tile in the future is not prohibitive, many of the open ditches of the county may be converted to "closed" tile drains.

Appendix



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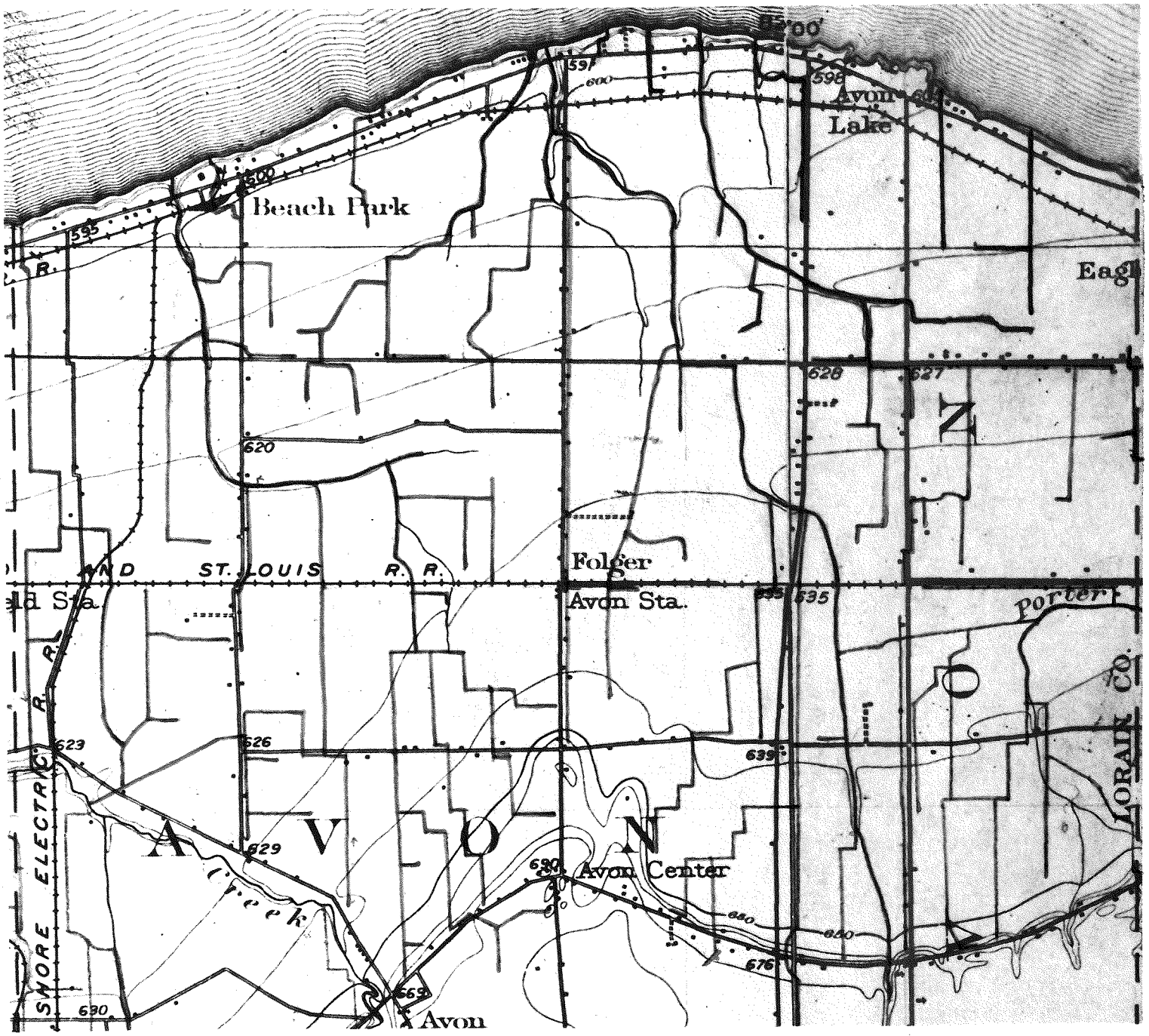
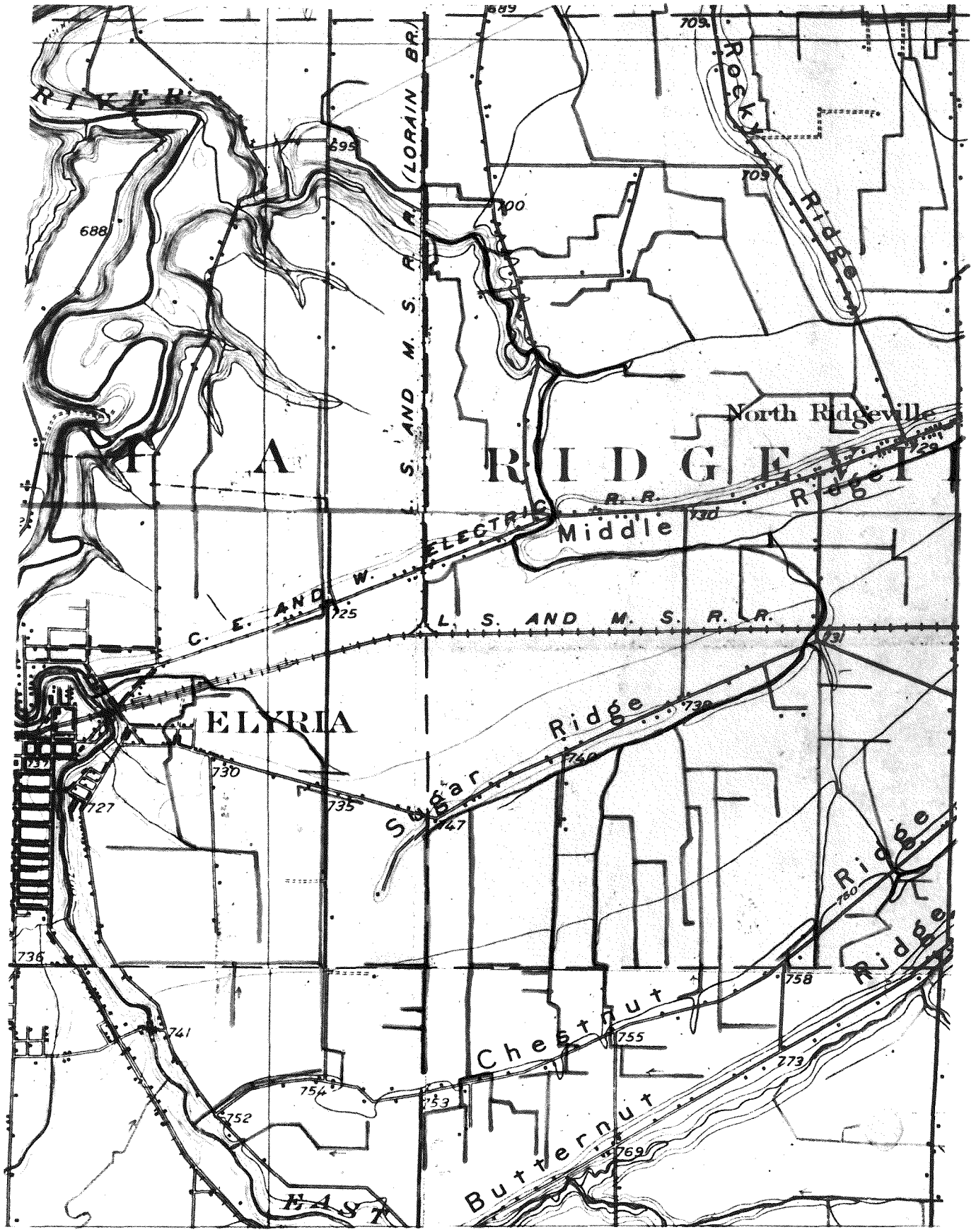


(Ditches and Drains in Red)

Scale 1:42,240

Plate III. Artificial Drainage Channels of the Lake Warren Plain, Avon Twp.

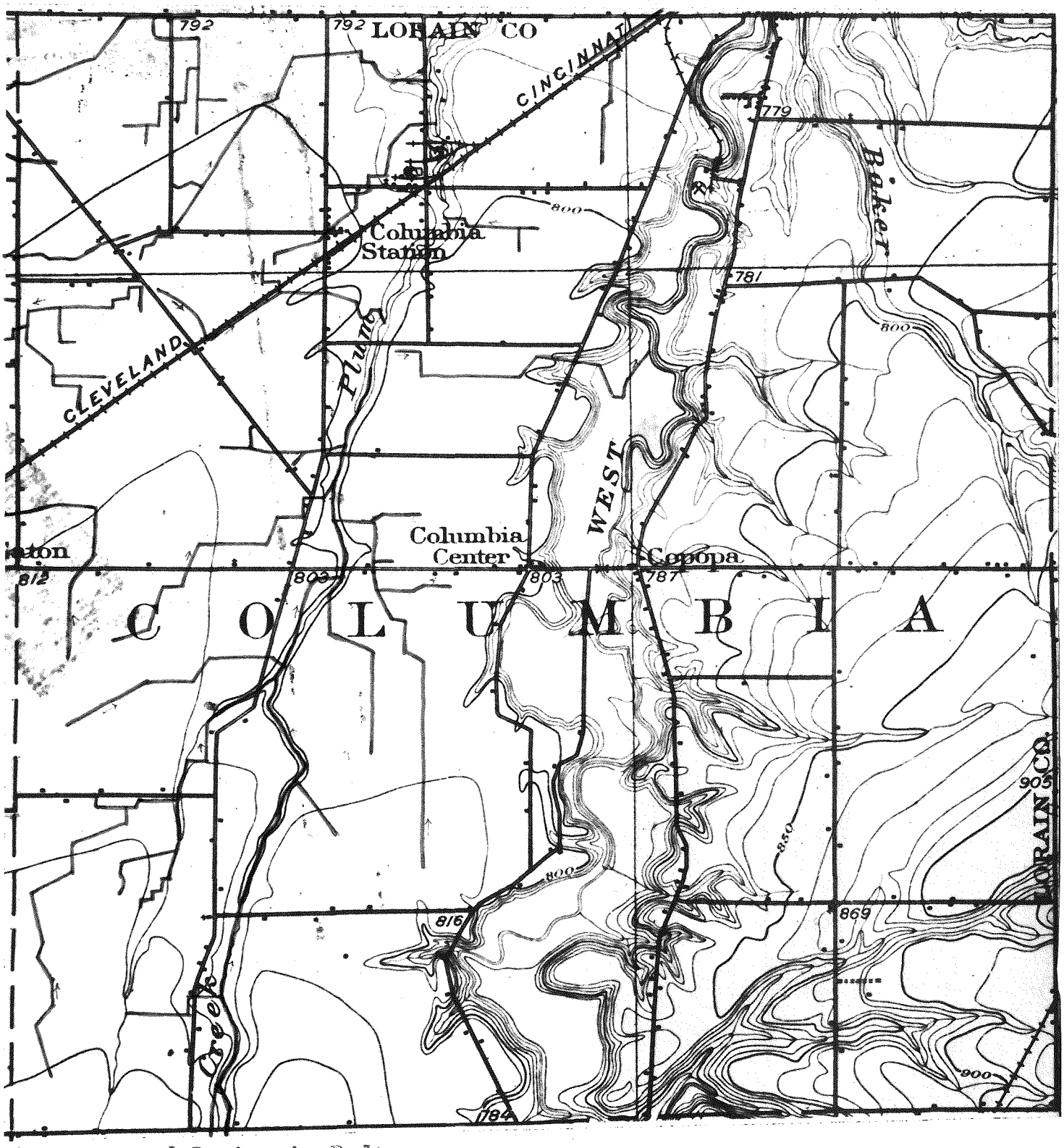
1946



(Ditches and Drains in Red)

Scale 1:42,240

Plate IV. Artificial Drainage Channels of the Inter-ridge Lake Plains Area. 1946



(Ditches and Drains in Red)

Scale 1:42,240

Plate V. Artificial Drainage Channels of Columbia Twp. 1946

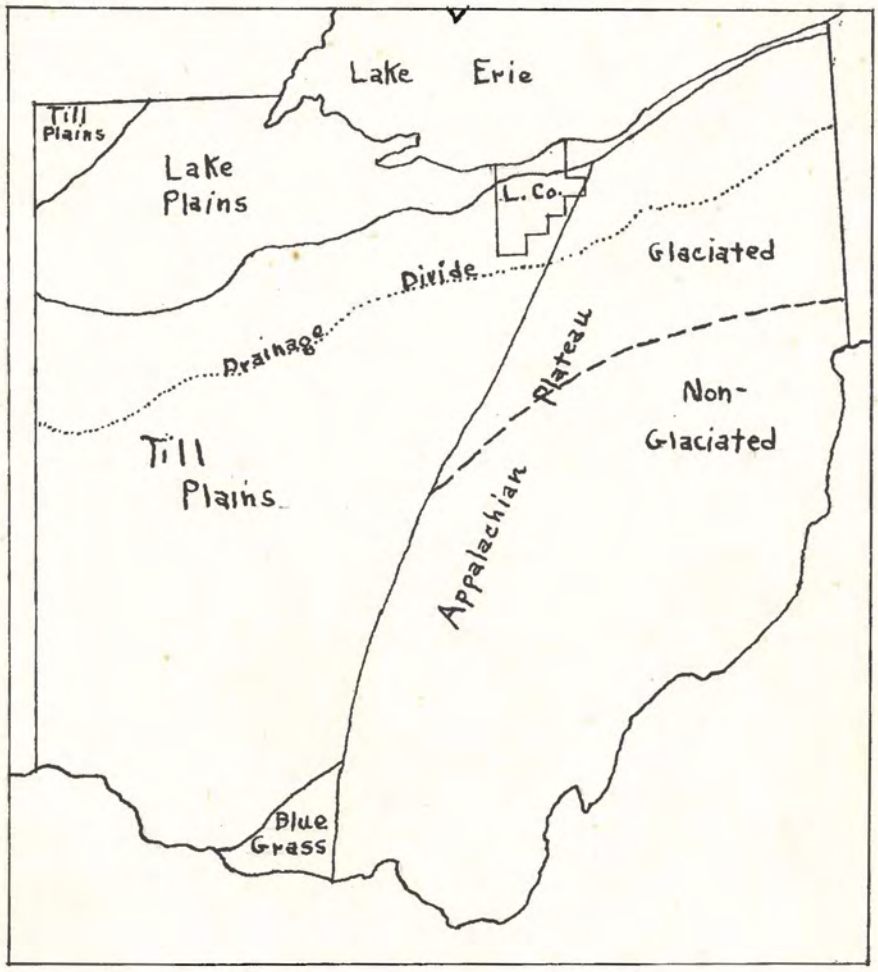
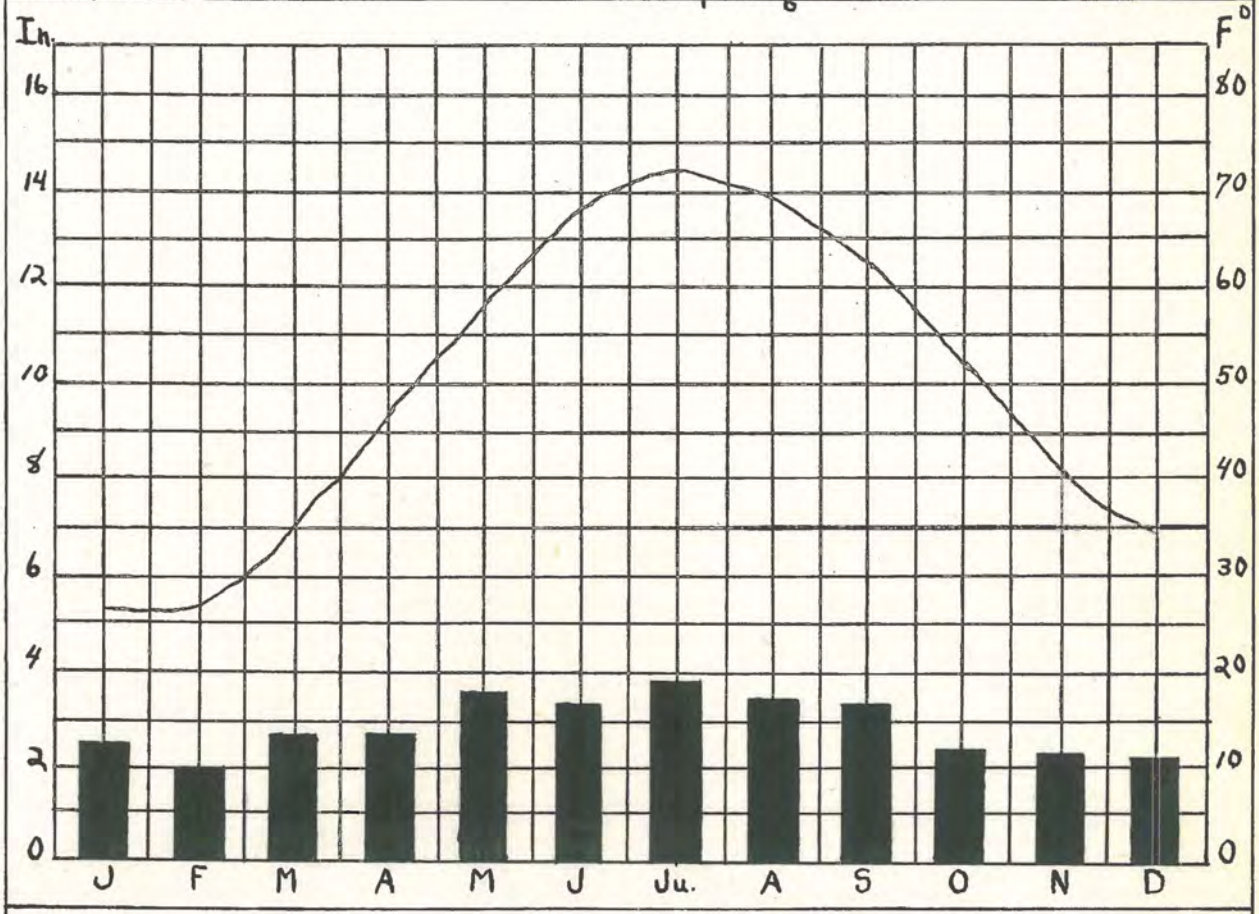


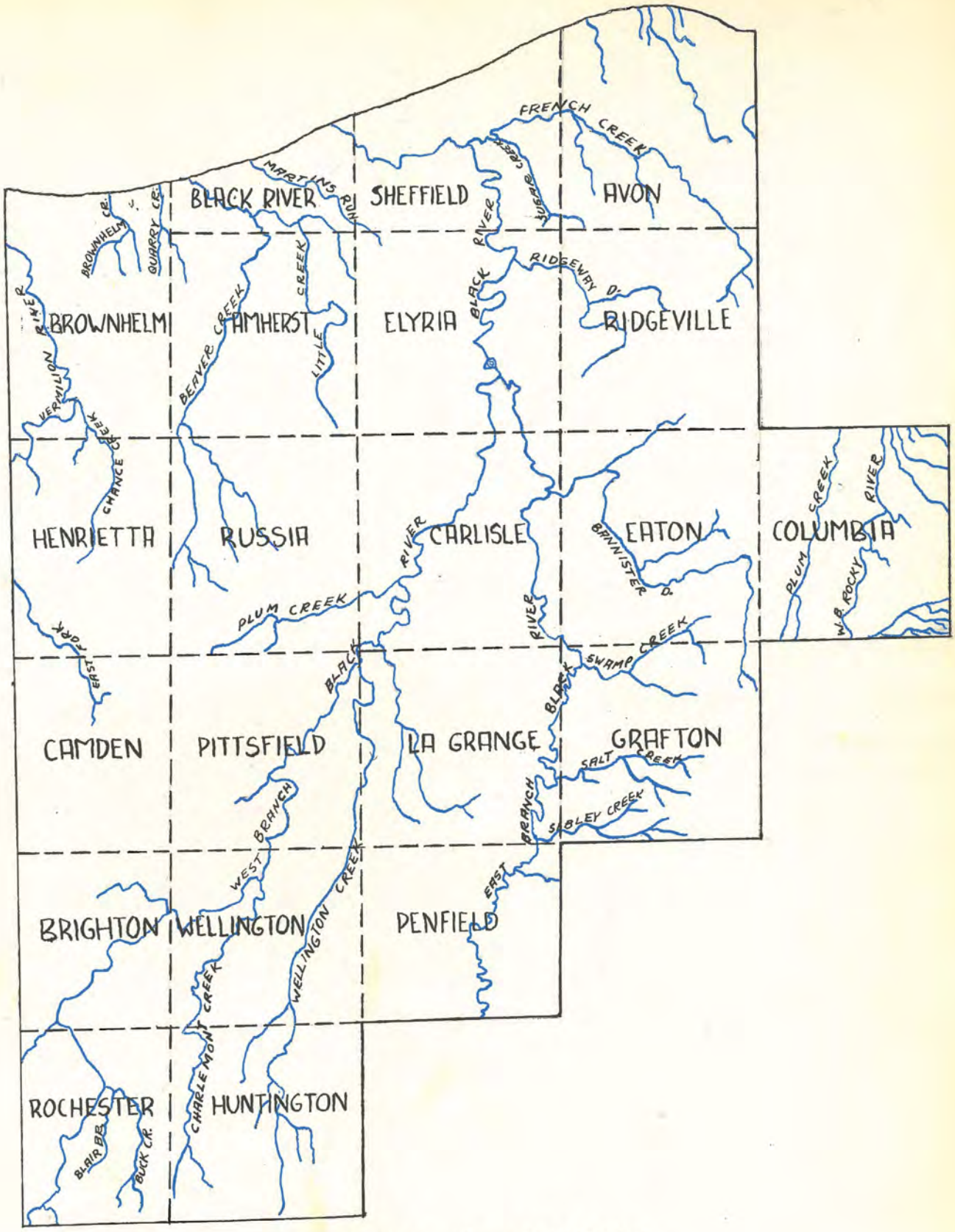
Figure 1. Physiographic Areas of Ohio

Station - Oberlin, Ohio	Climatic Type	Dfa
Location - 41° 17' N. Lat. - 82° 12' W. Long.	Altitude	817 ft.
Total Precip. - 34.50"	Mean Annual Temp.	49.2° F.
Av. Annual Snowfall - 38.0"	Temp. Range	56.5° F.



High. Temp. - 105° F, Aug. 5, 1918	Length of Growing Season - 154 Days
Low. Temp. - -23° F, Jan. 13, 1912	

Figure 2. Climatic Chart: Oberlin, Lorain County, Ohio



Approximate Scale 1:250,000

Figure 3. The Rivers in Lorain County

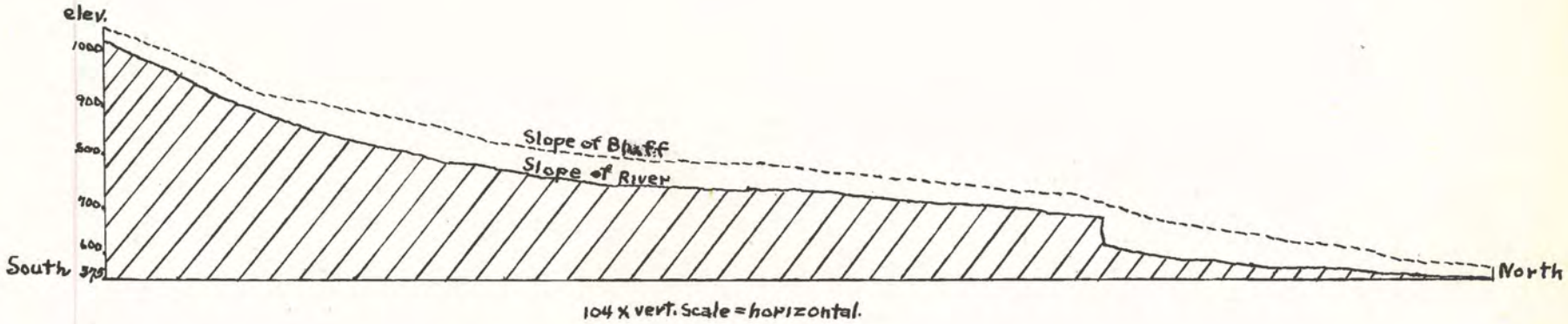
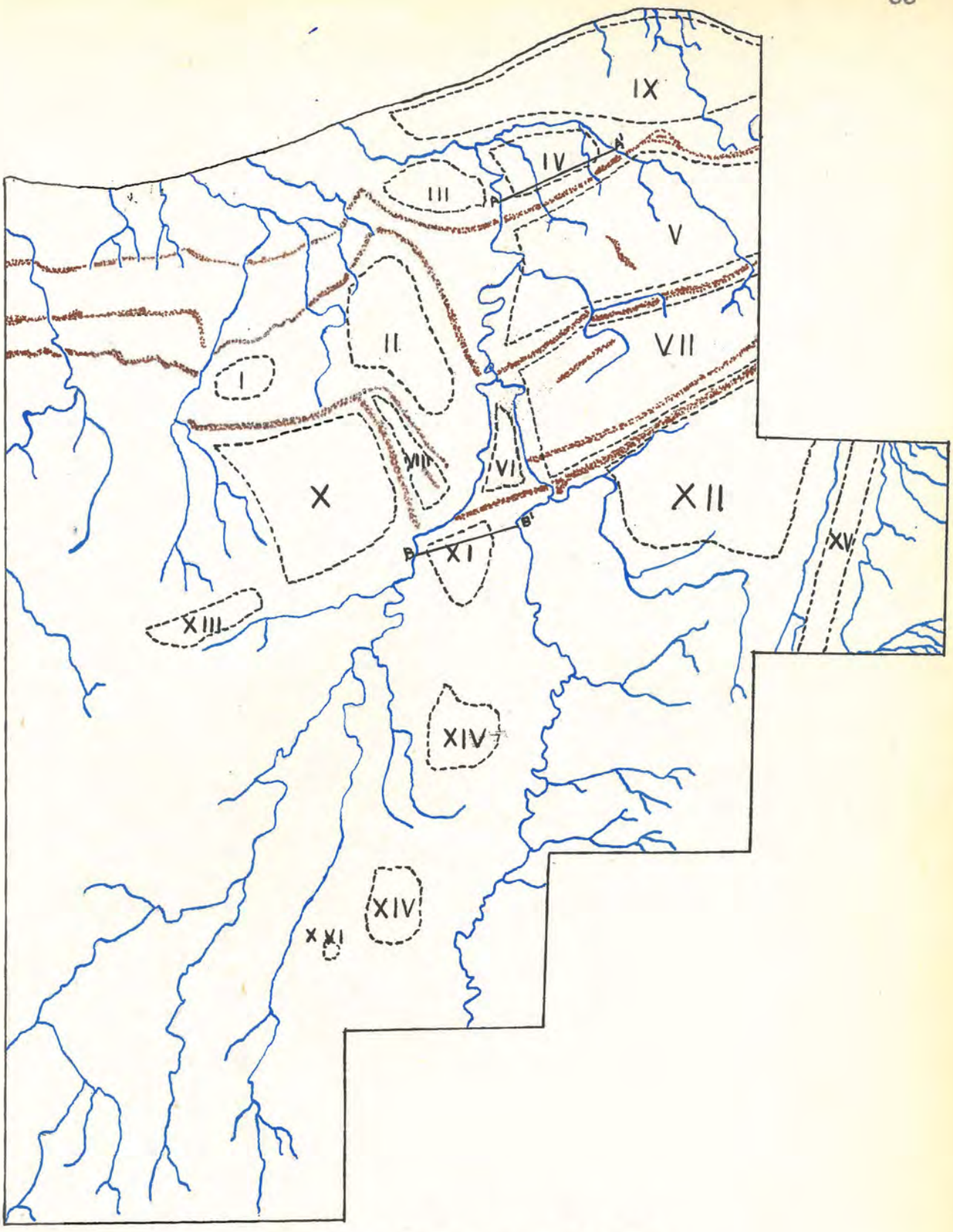
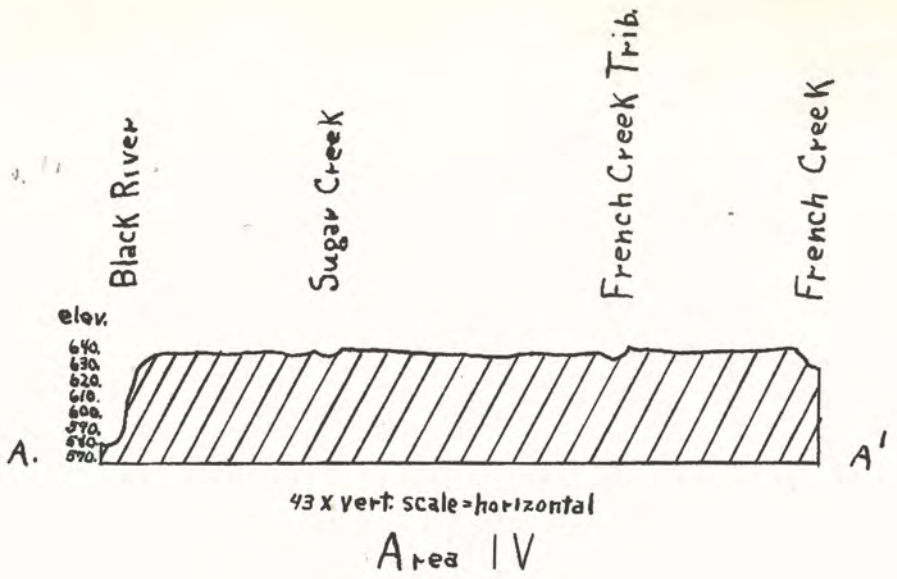


Figure 4. Profile: The West Branch of Black River and Black River Proper, and the Bluffs Along the River



Approximate Scale 1:250,000

Figure 5. Areas of Poor Natural Drainage, Lorain County



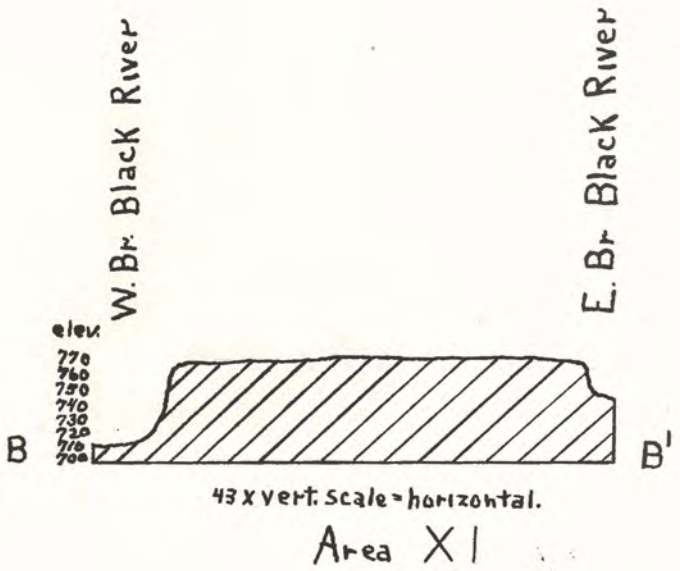


Figure 6. Interstream Areas in Cross-section

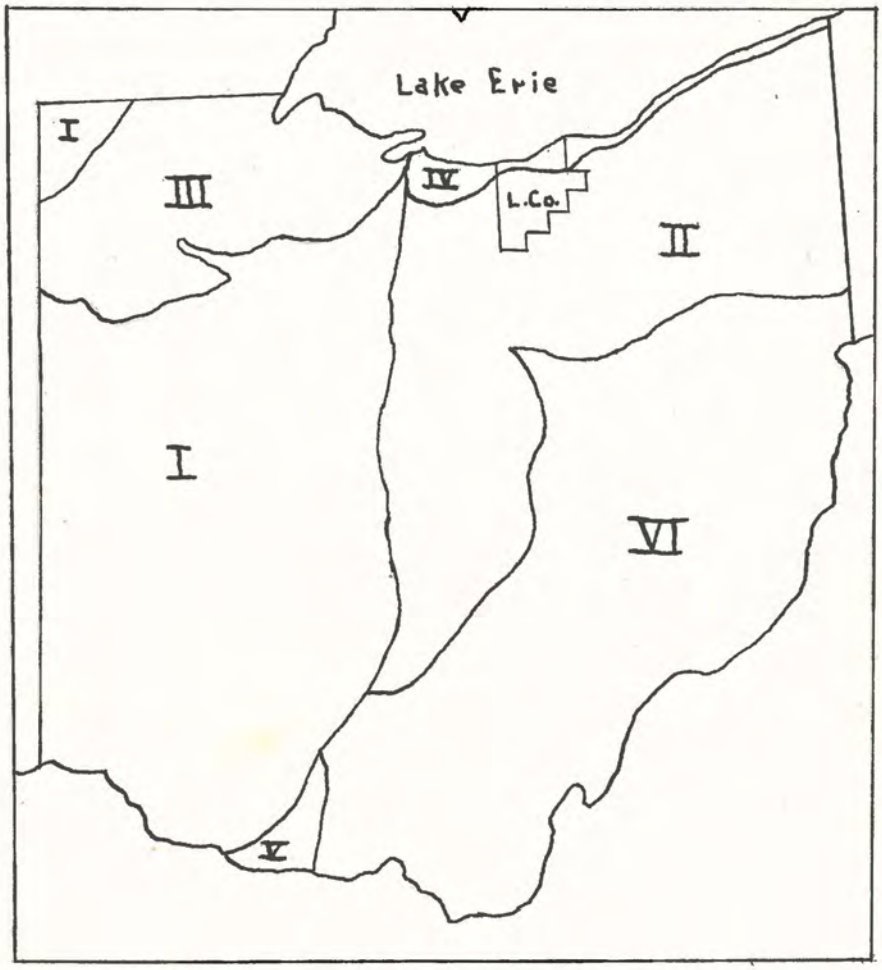
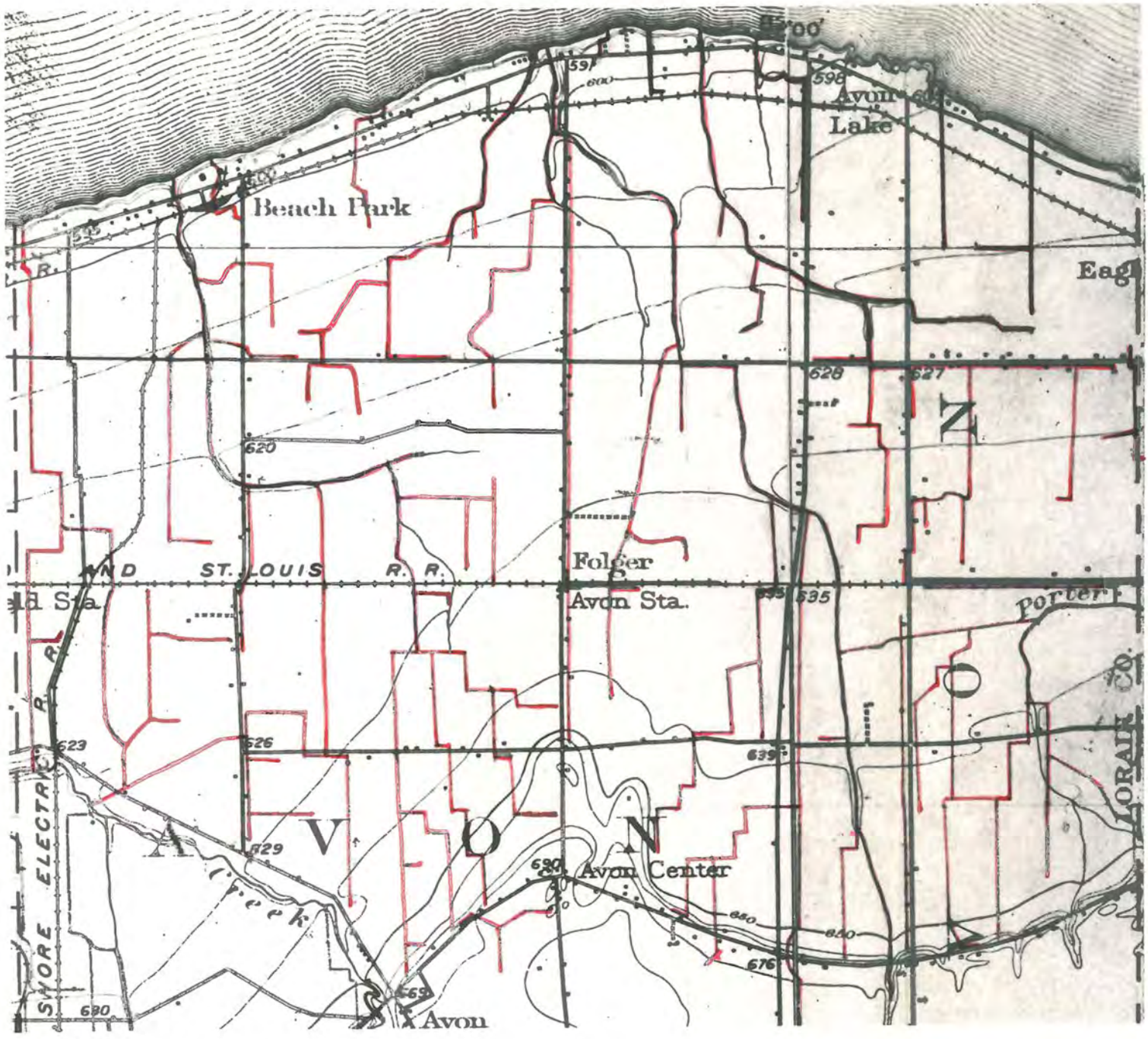


Figure 7. Soil Areas of Ohio

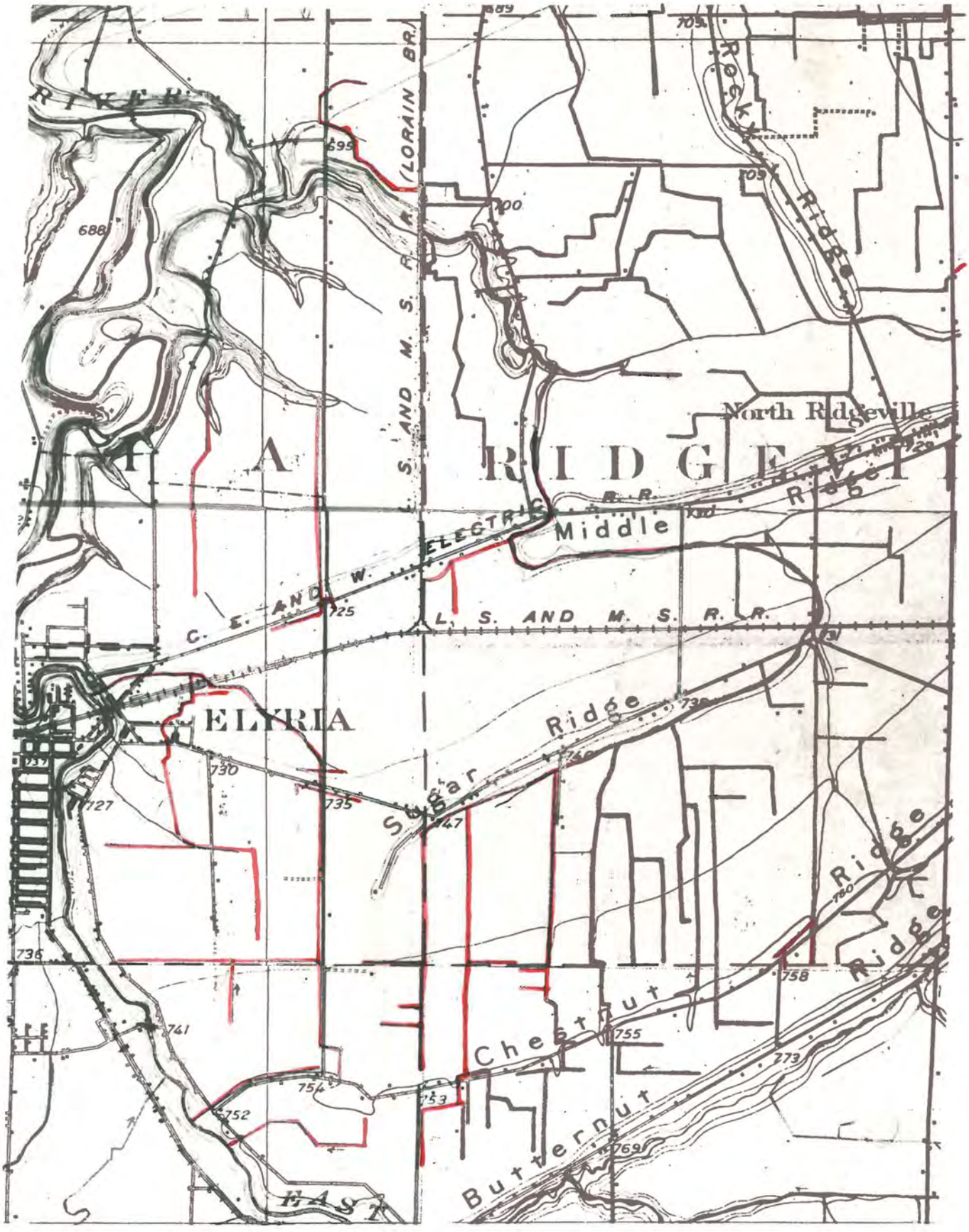


(Ditches and Drains in Red)

Scale 1:42,240

Plate III. Artificial Drainage Channels of the Lake Warren Plain, Avon Twp.

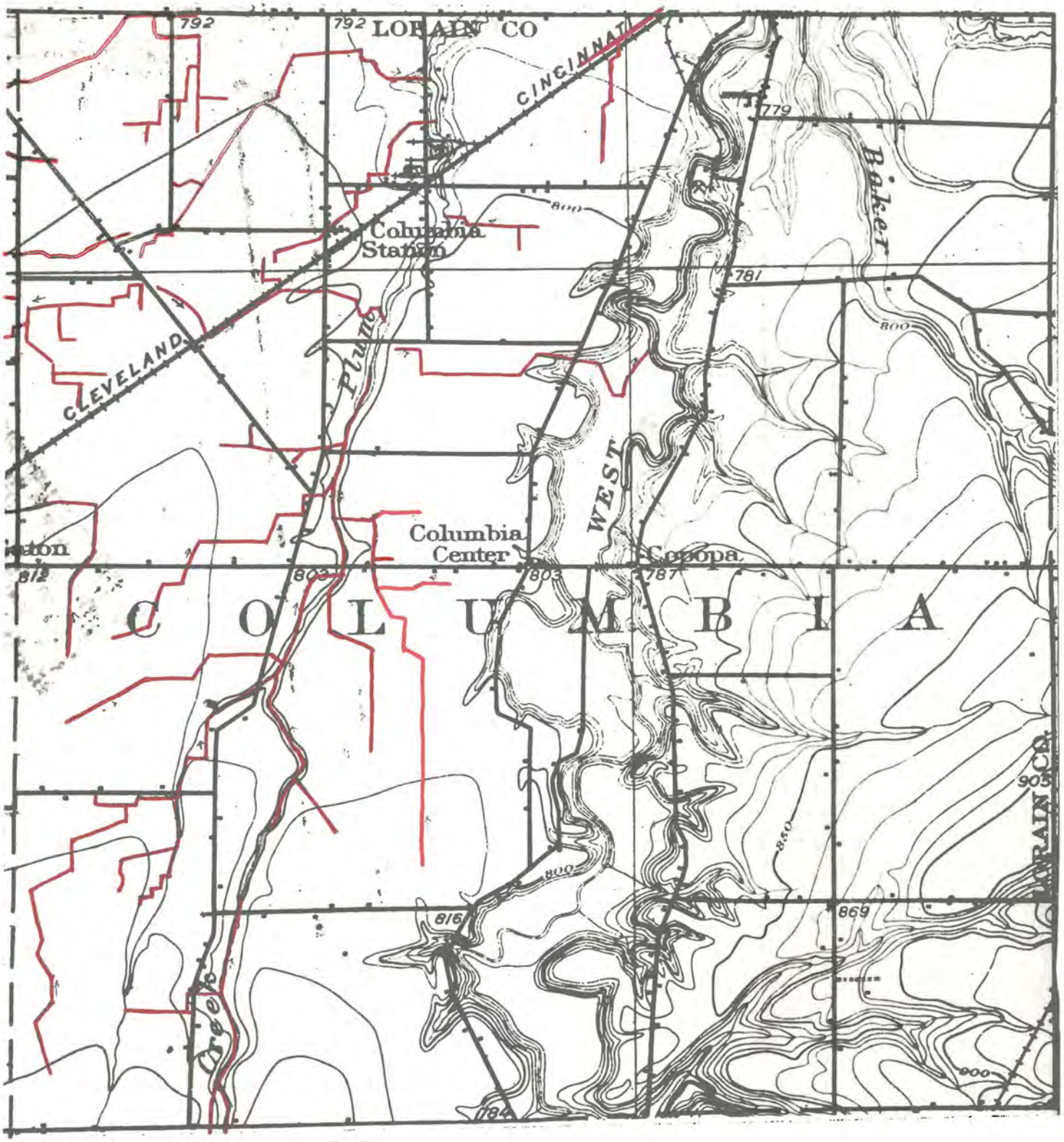
1946



(Ditches and Drains in Red)

Scale 1:42,240

Plate IV. Artificial Drainage Channels of the Inter-ridge Lake Plains Area. 1946



(Ditches and Drains in Red)

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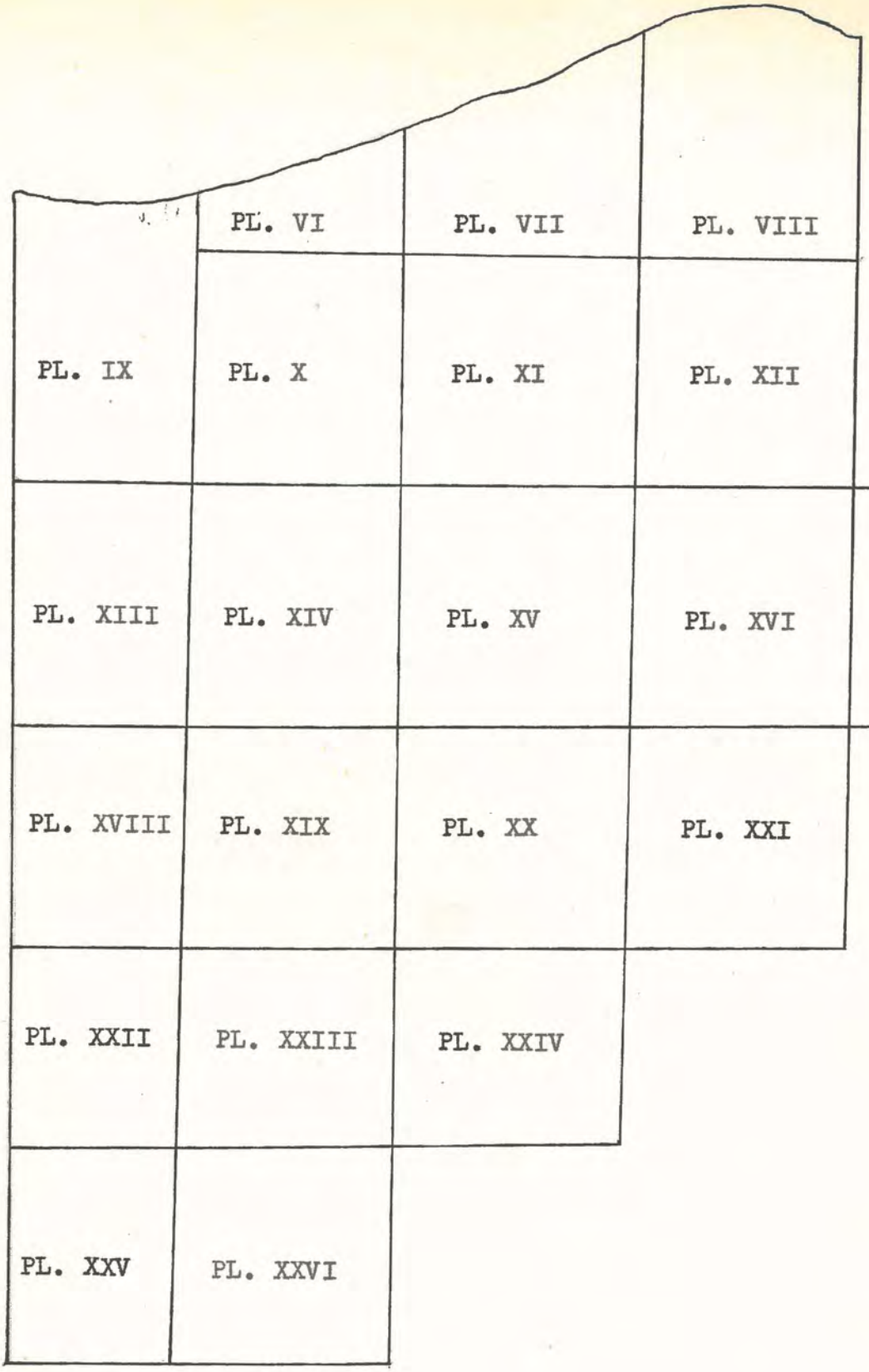
Plate V. Artificial Drainage Channels of Columbia Twp. 1946



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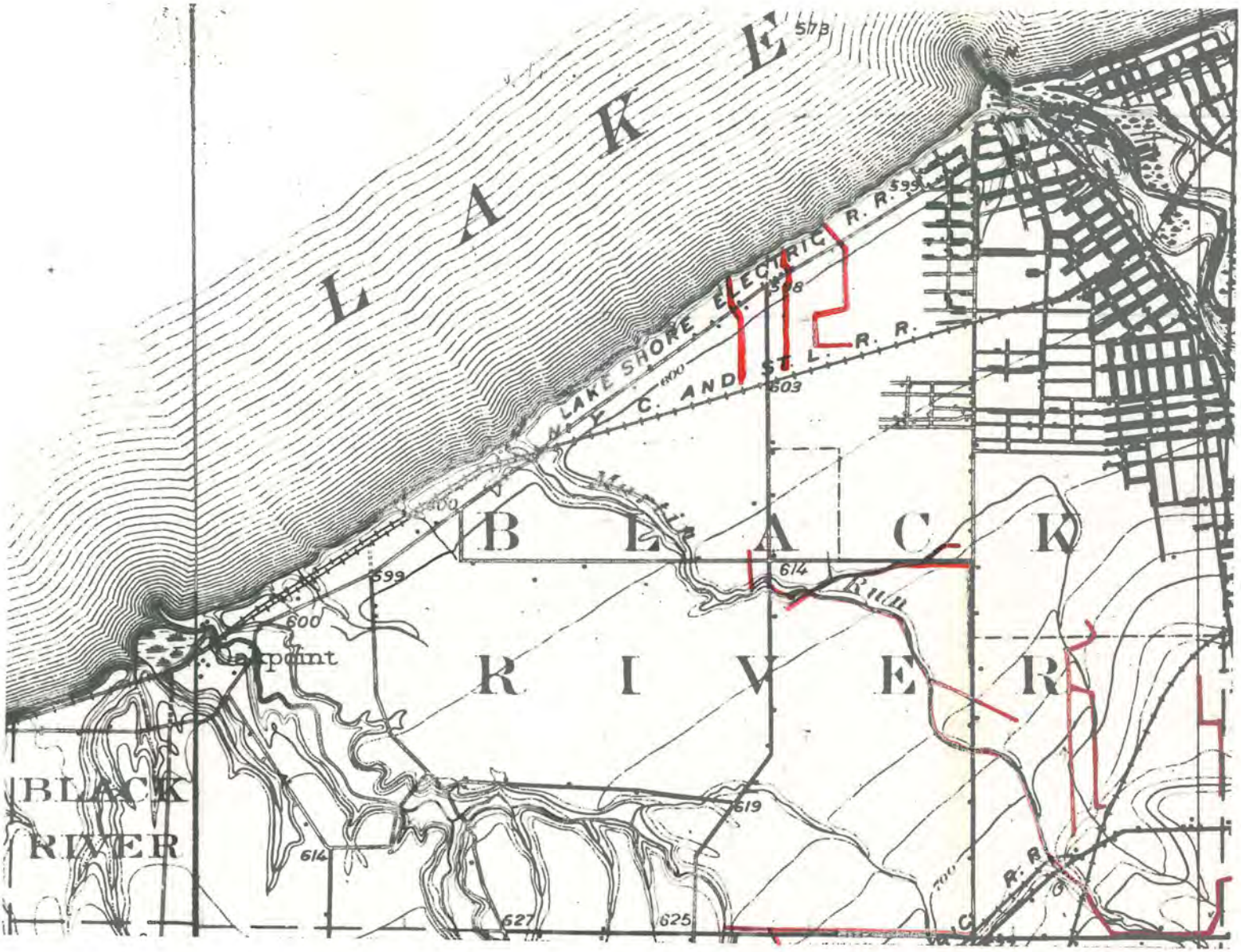

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Plate VI. Artificial Drainage Channels of Black River Twp. 1946

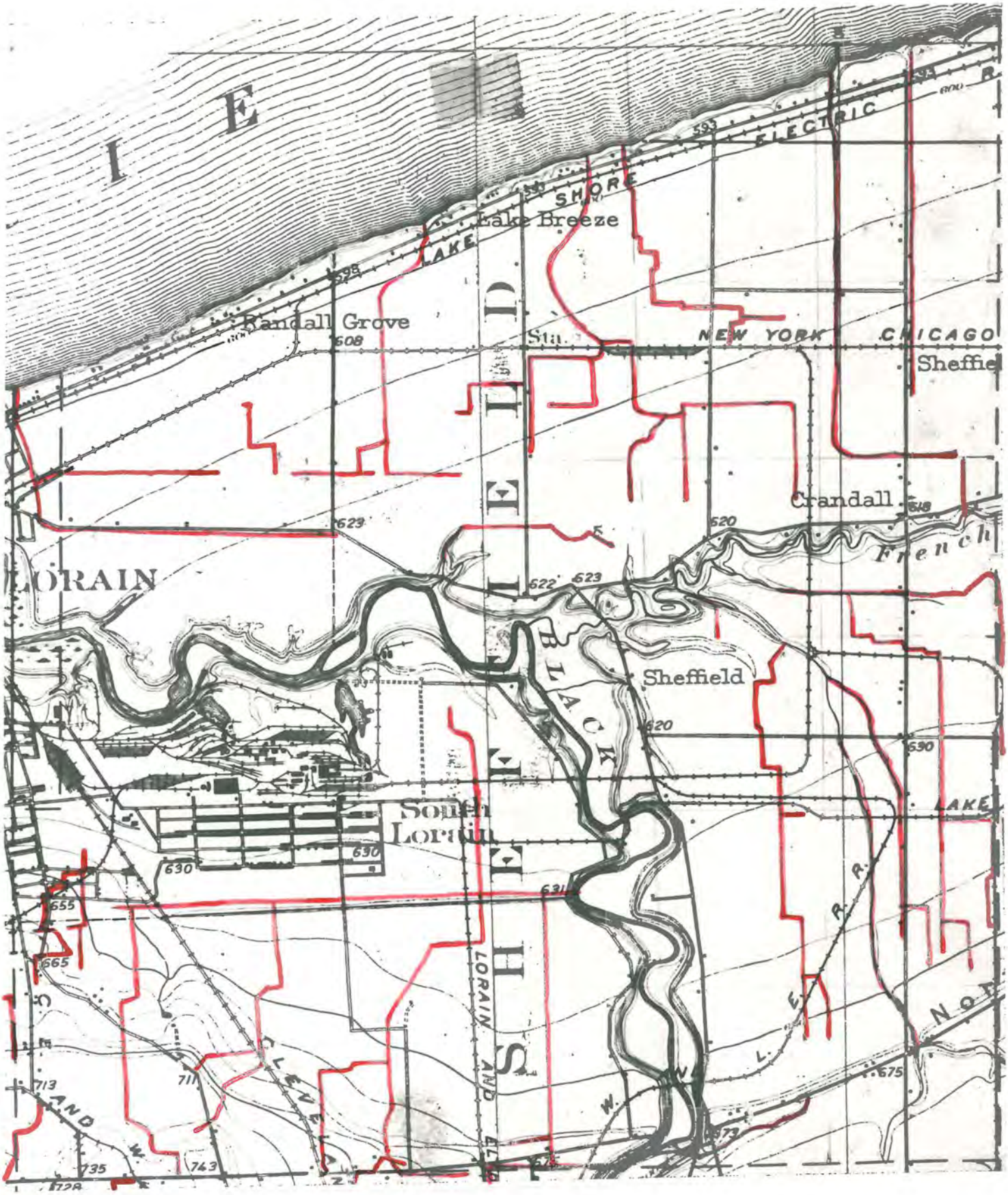

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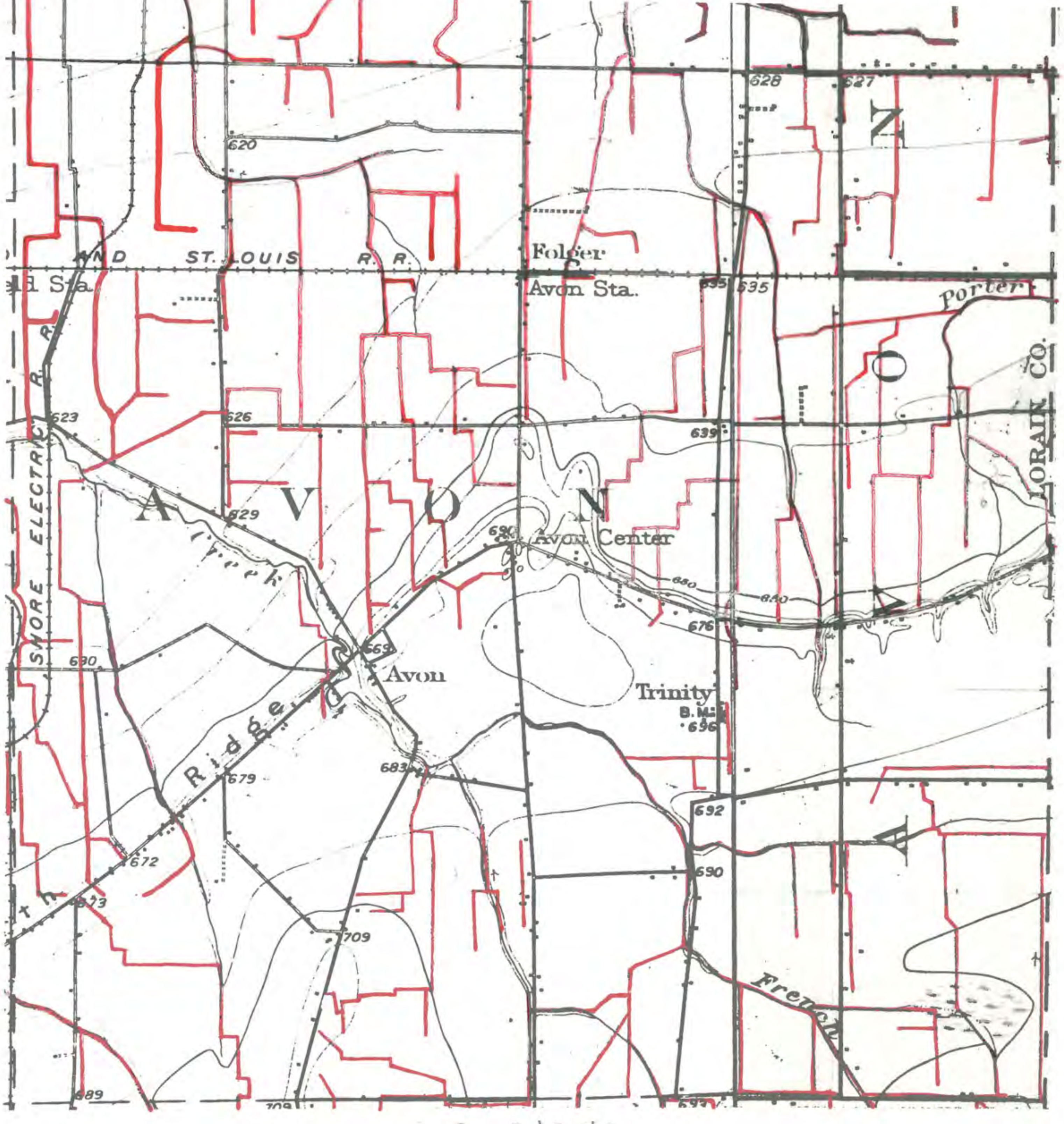
Plate VII. Artificial Drainage Channels of Sheffield Twp. 1946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Avon
Avon Sta.
Folger
Trinity
B.M. 696
LORAIN CO.
ST. LOUIS R. R.
SHORE ELECTRIC R. R.
Ridge
Creek
French
Porter
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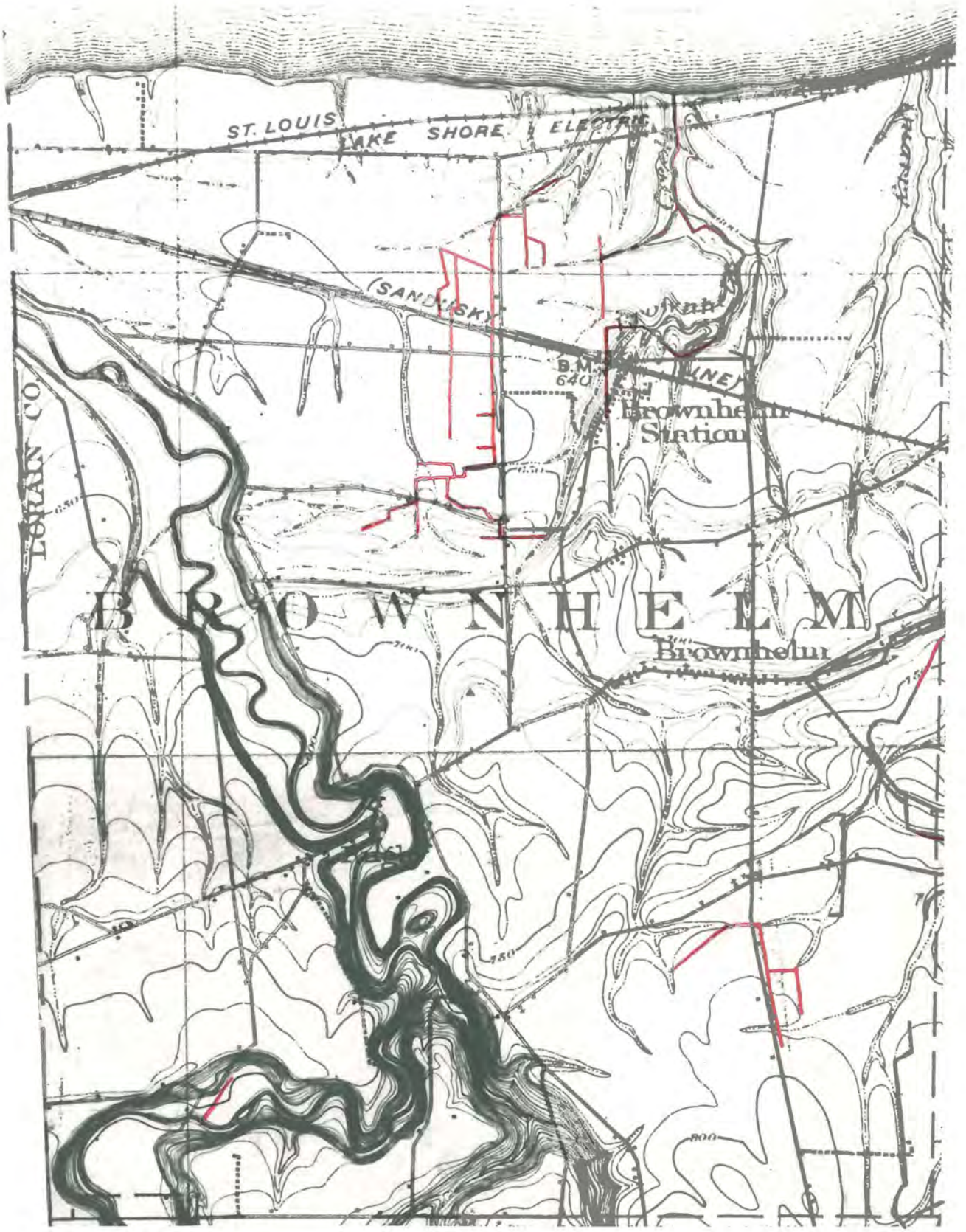

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Plate IX. Artificial Drainage Channels of Brownhelm Twp. 1946

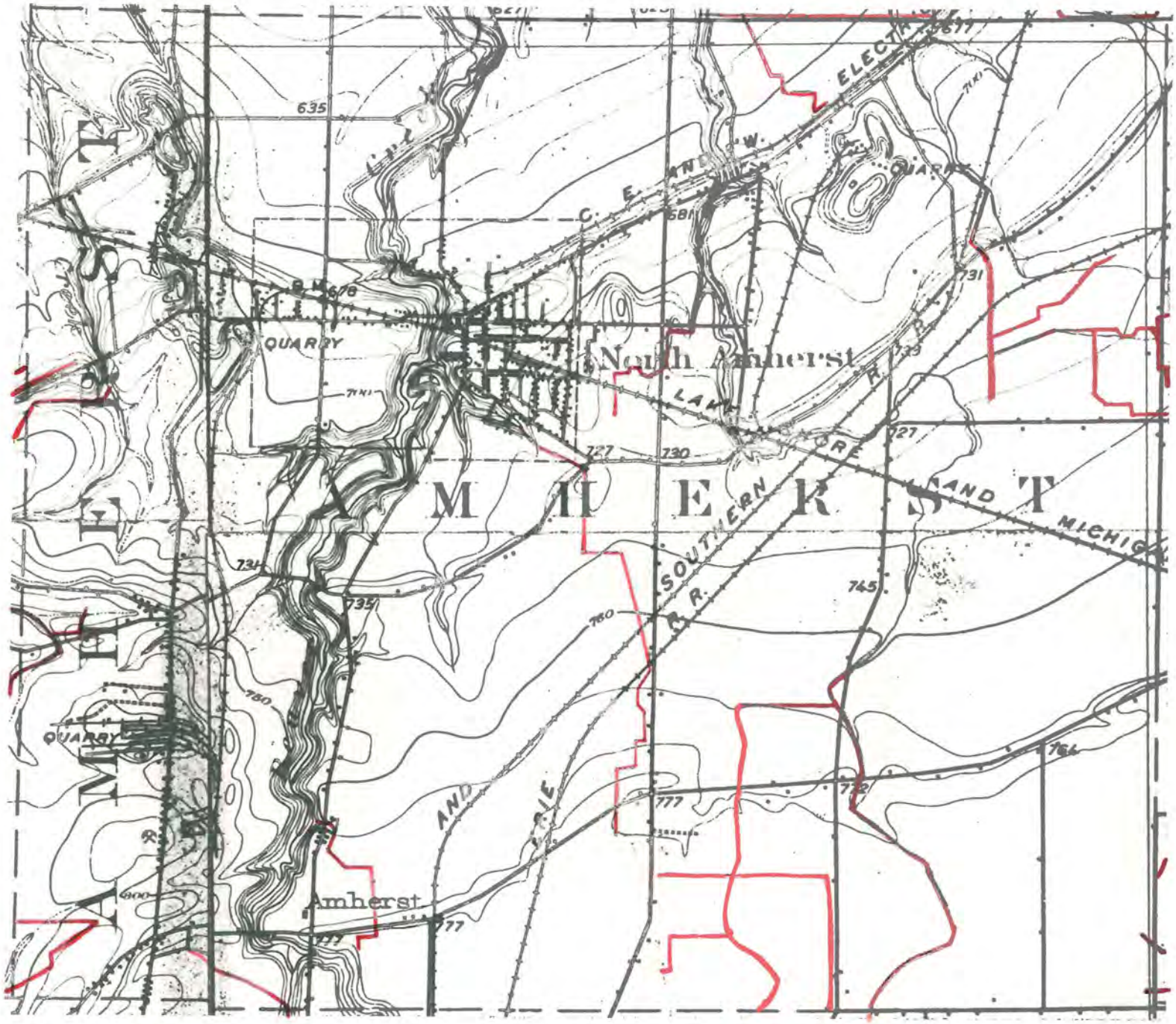

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Plate X. Artificial Drainage Channels of Amherst Twp. 1946

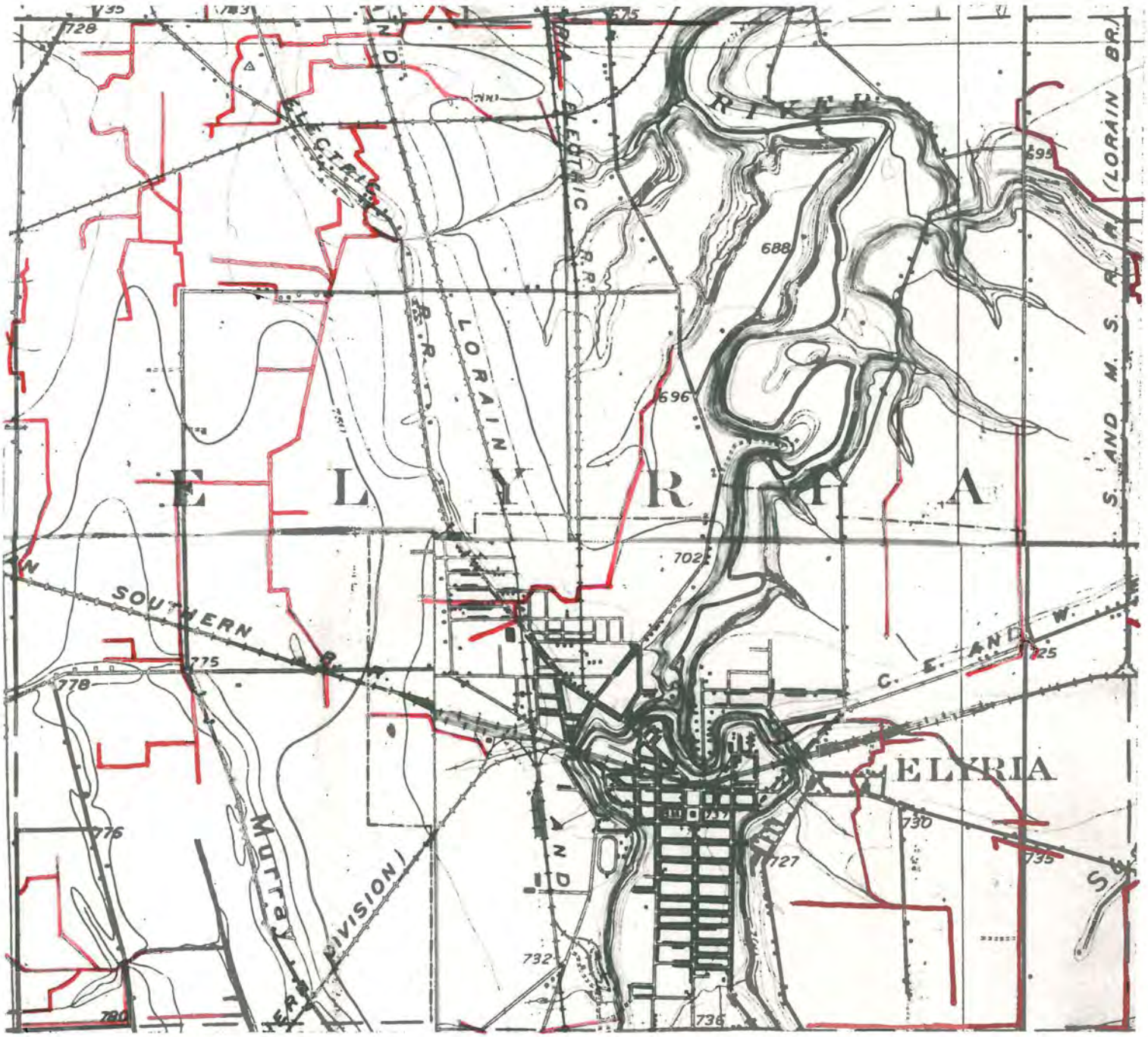

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Plate XI. Artificial Drainage Channels of Elyria Twp. 1946

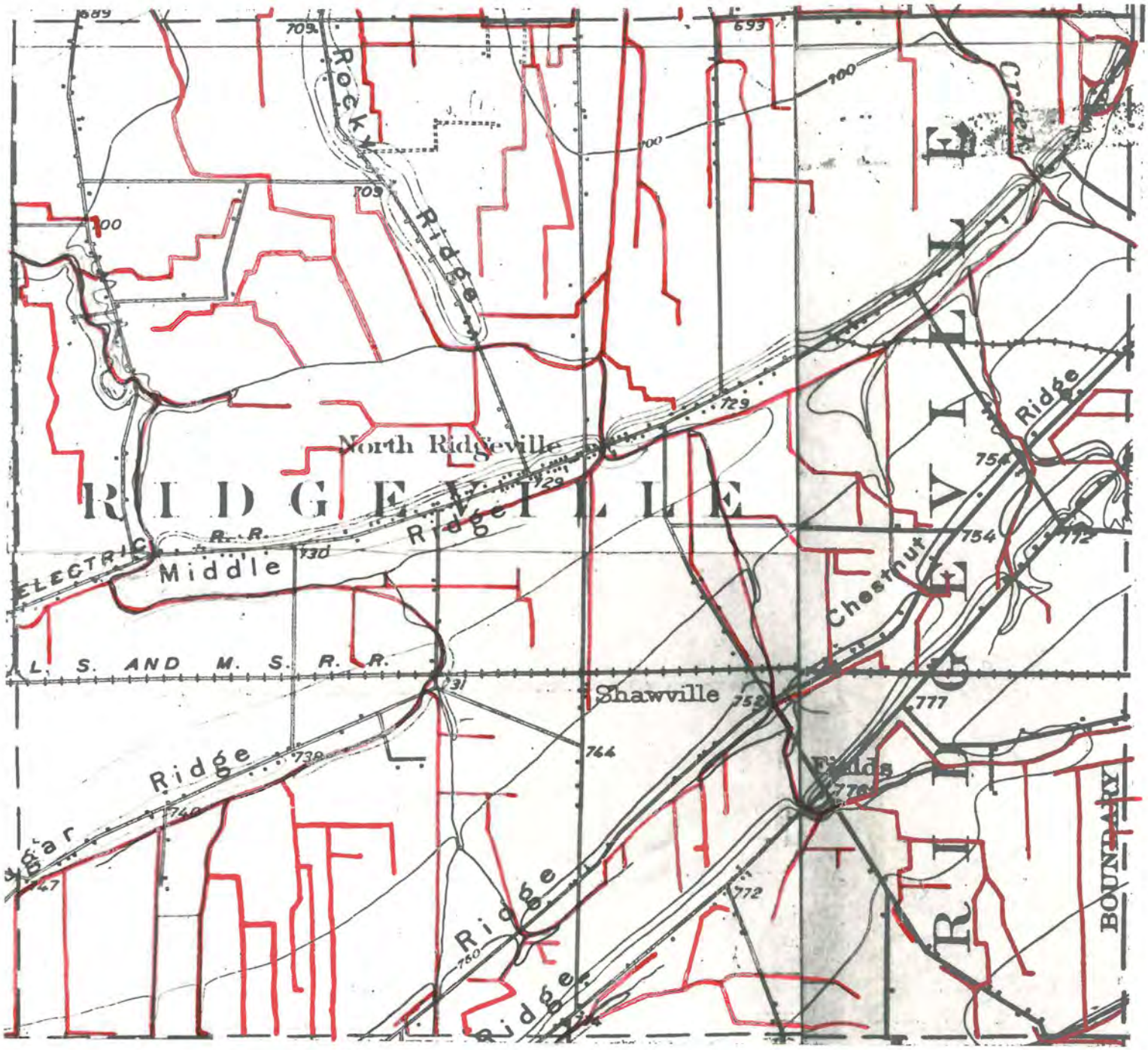

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Plate XII. Artificial Drainage Channels of Ridgeville Twp. 1946

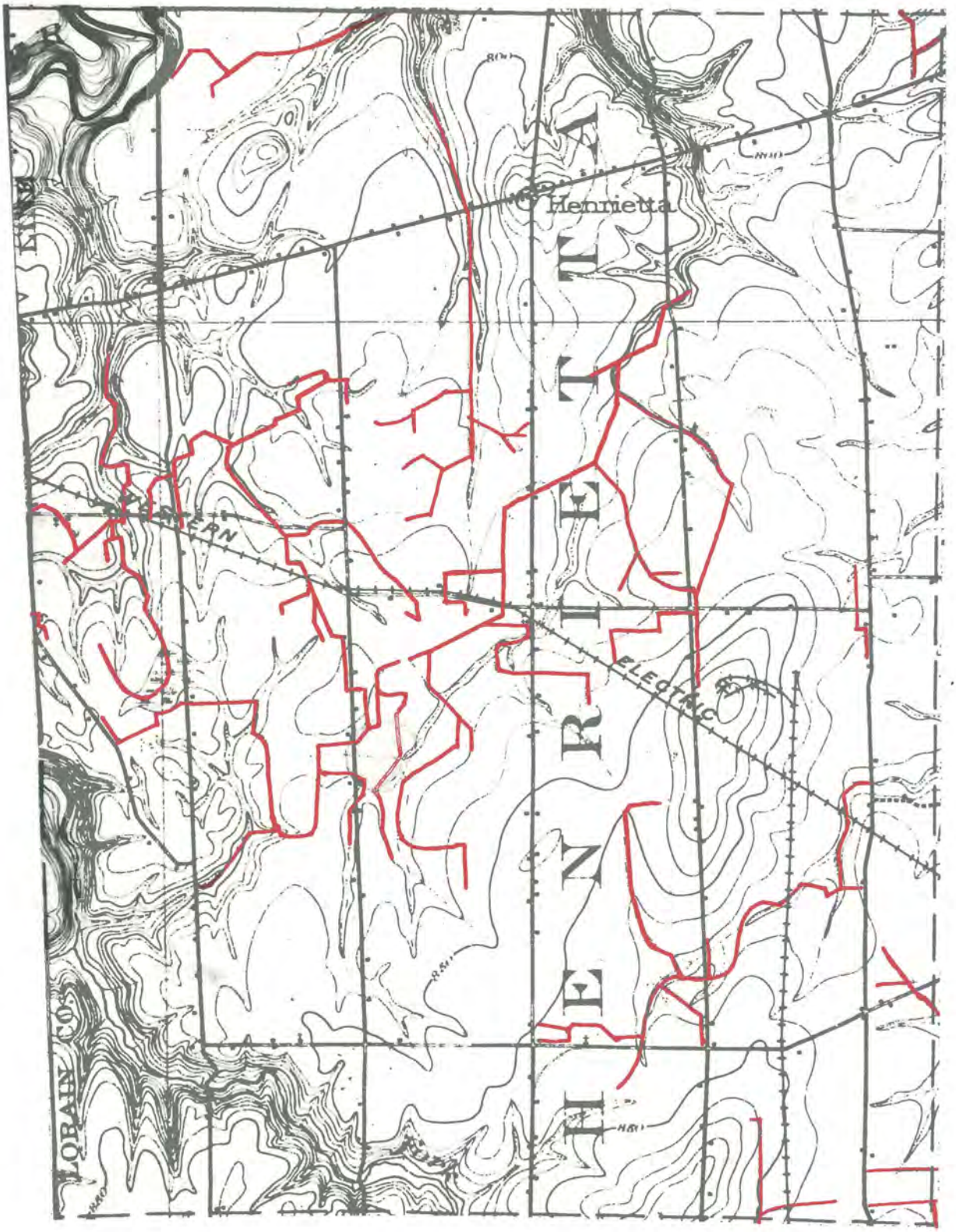

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Plate XIII. Artificial Drainage Channels of Henrietta Twp. 1946

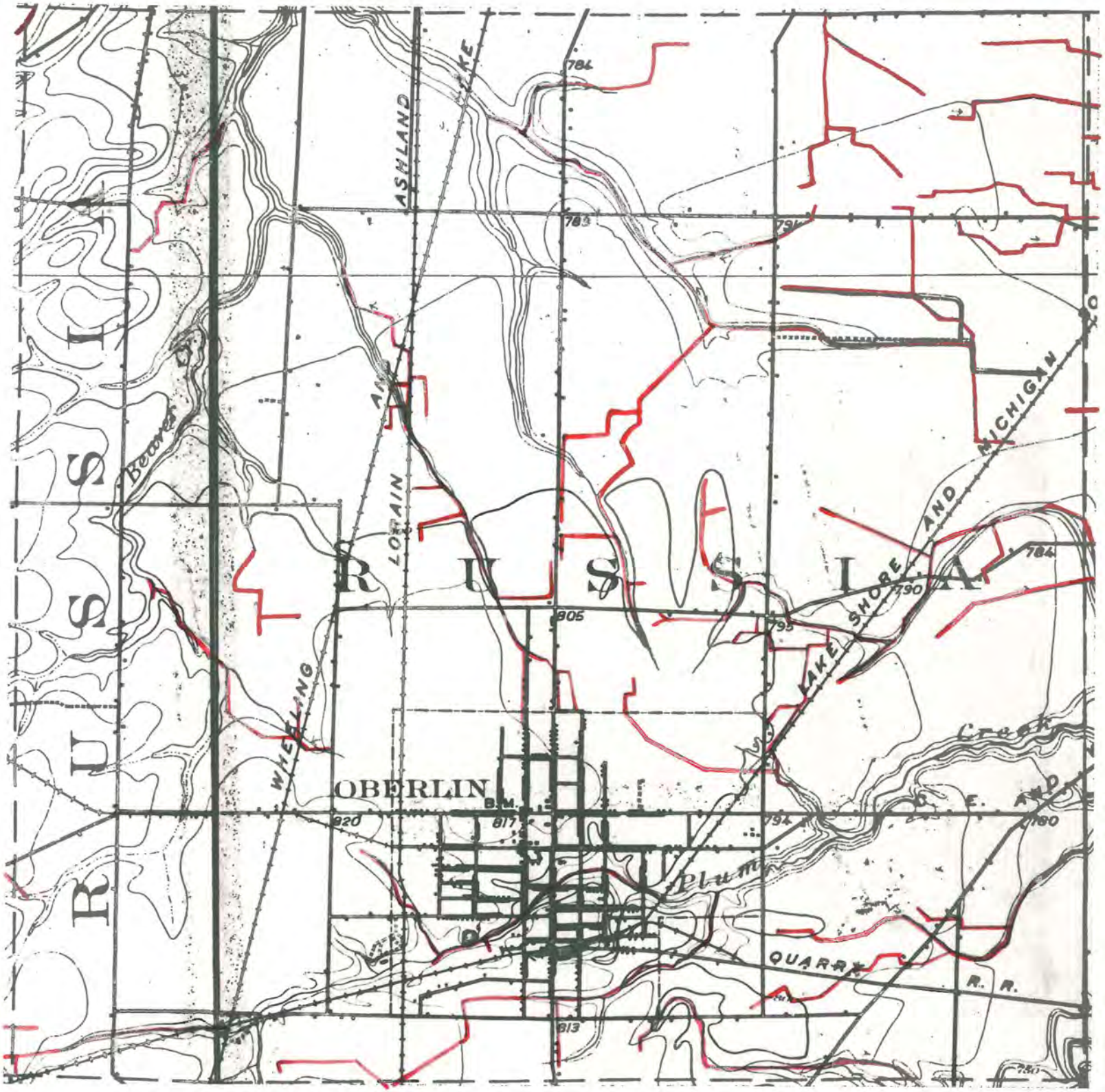

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Plate XIV. Artificial Drainage Channels of Russia Twp. 1946

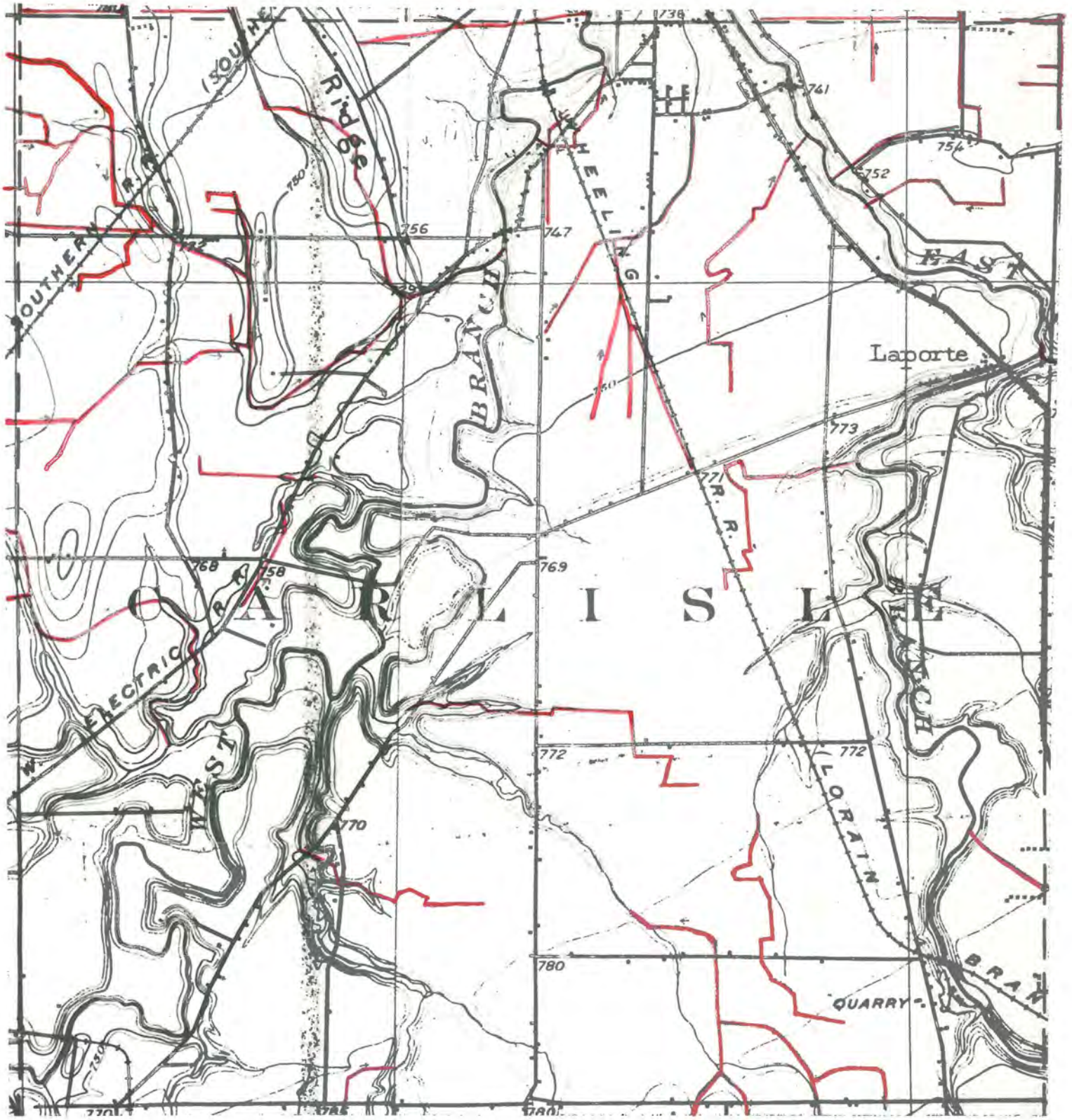

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Plate XV. Artificial Drainage Channels of Carlisle Twp. 1946

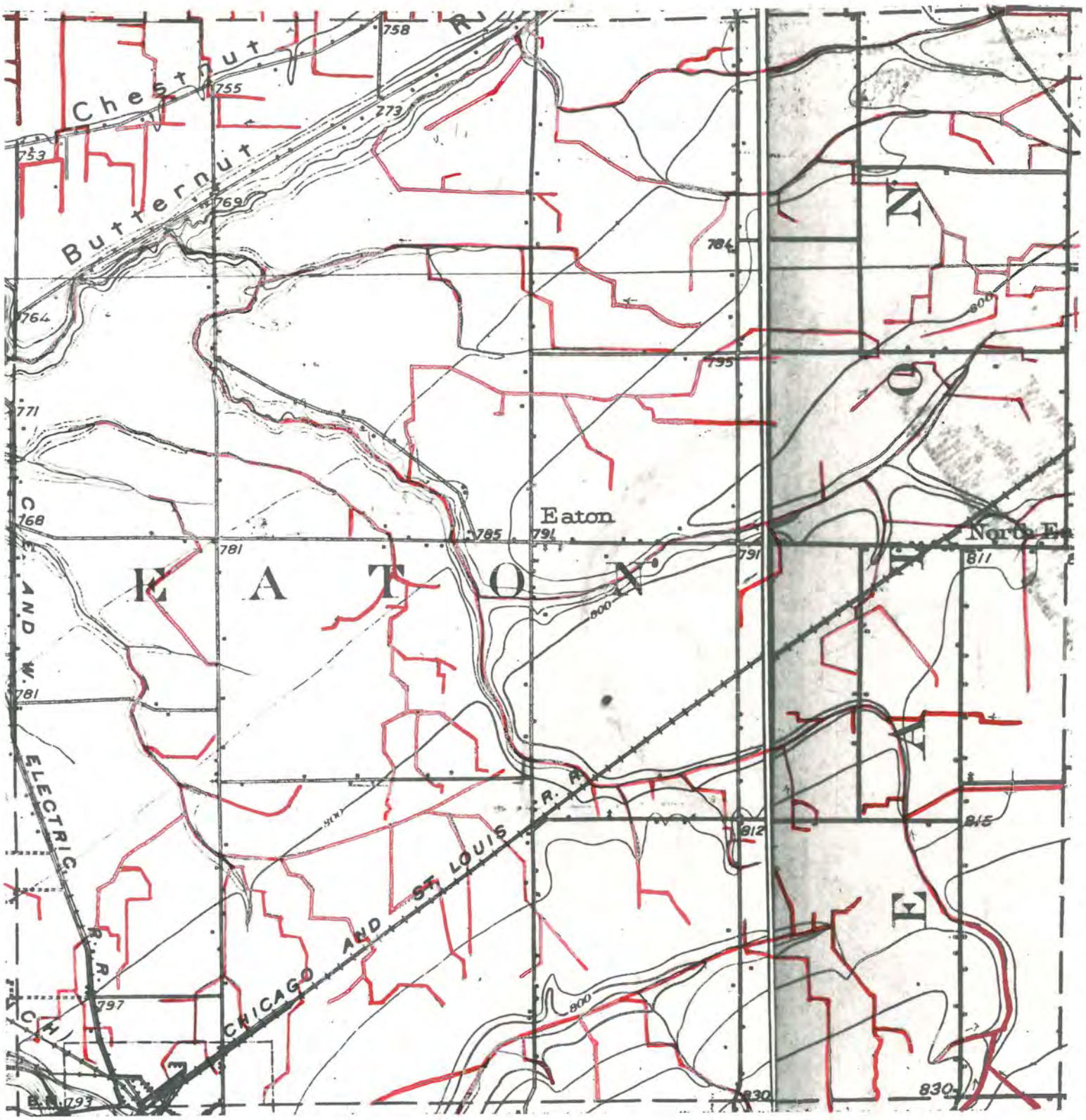

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Plate XVI. Artificial Drainage Channels of Eaton Twp. 1946

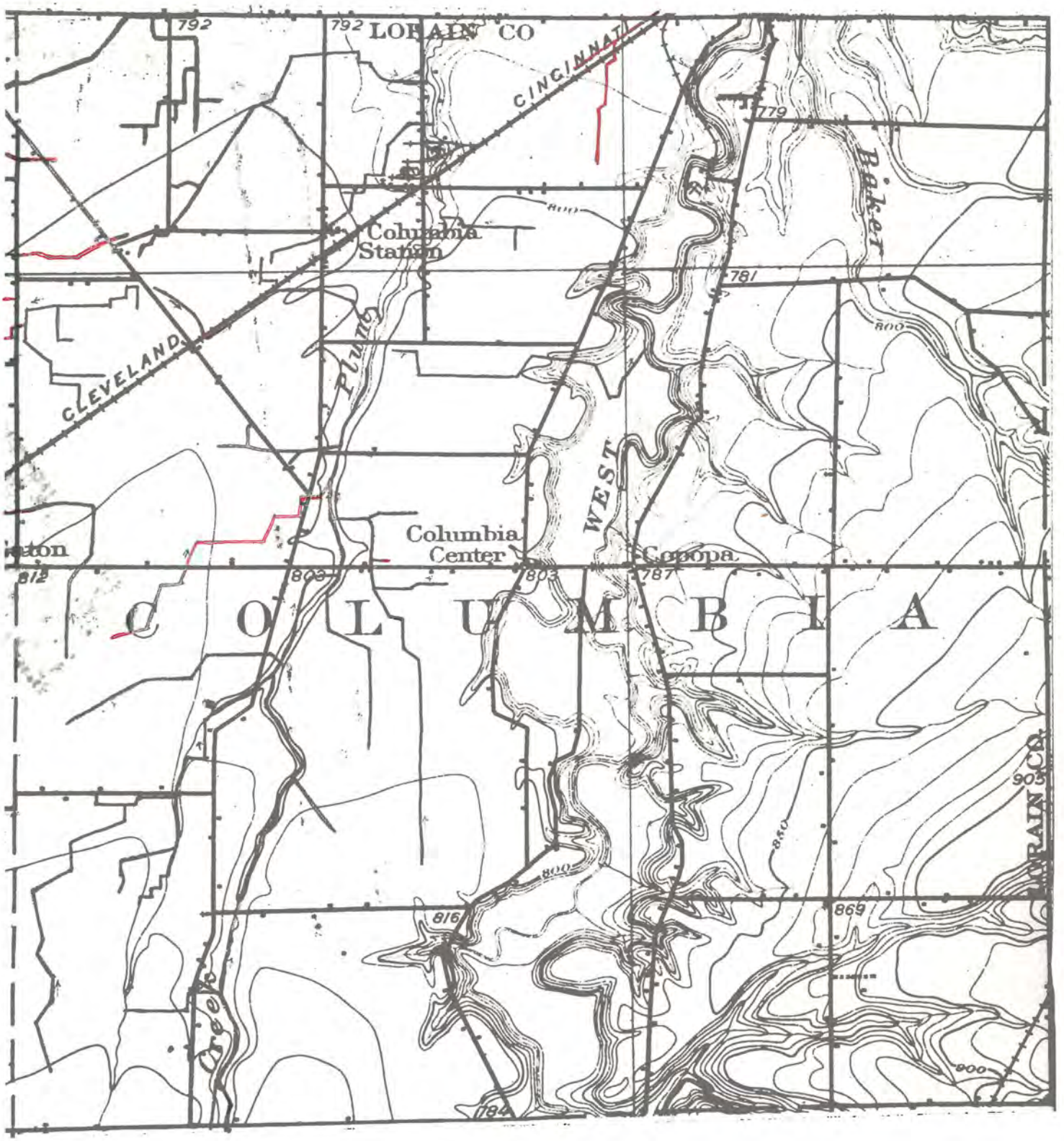

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Plate XVII. Artificial Drainage Channels of Columbia Twp. 1946

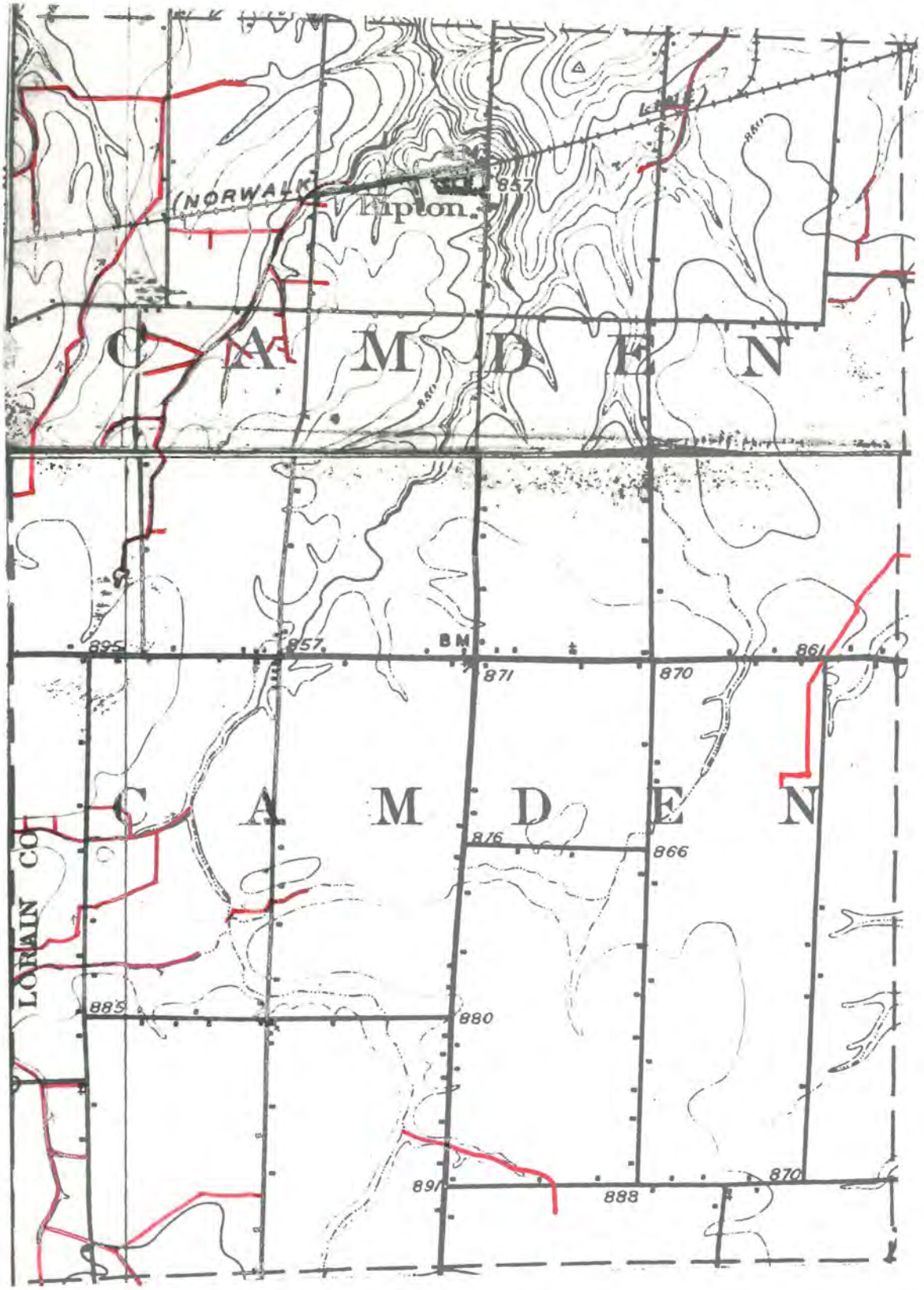

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Plate XVIII. Artificial Drainage Channels of Camden Twp. 1946

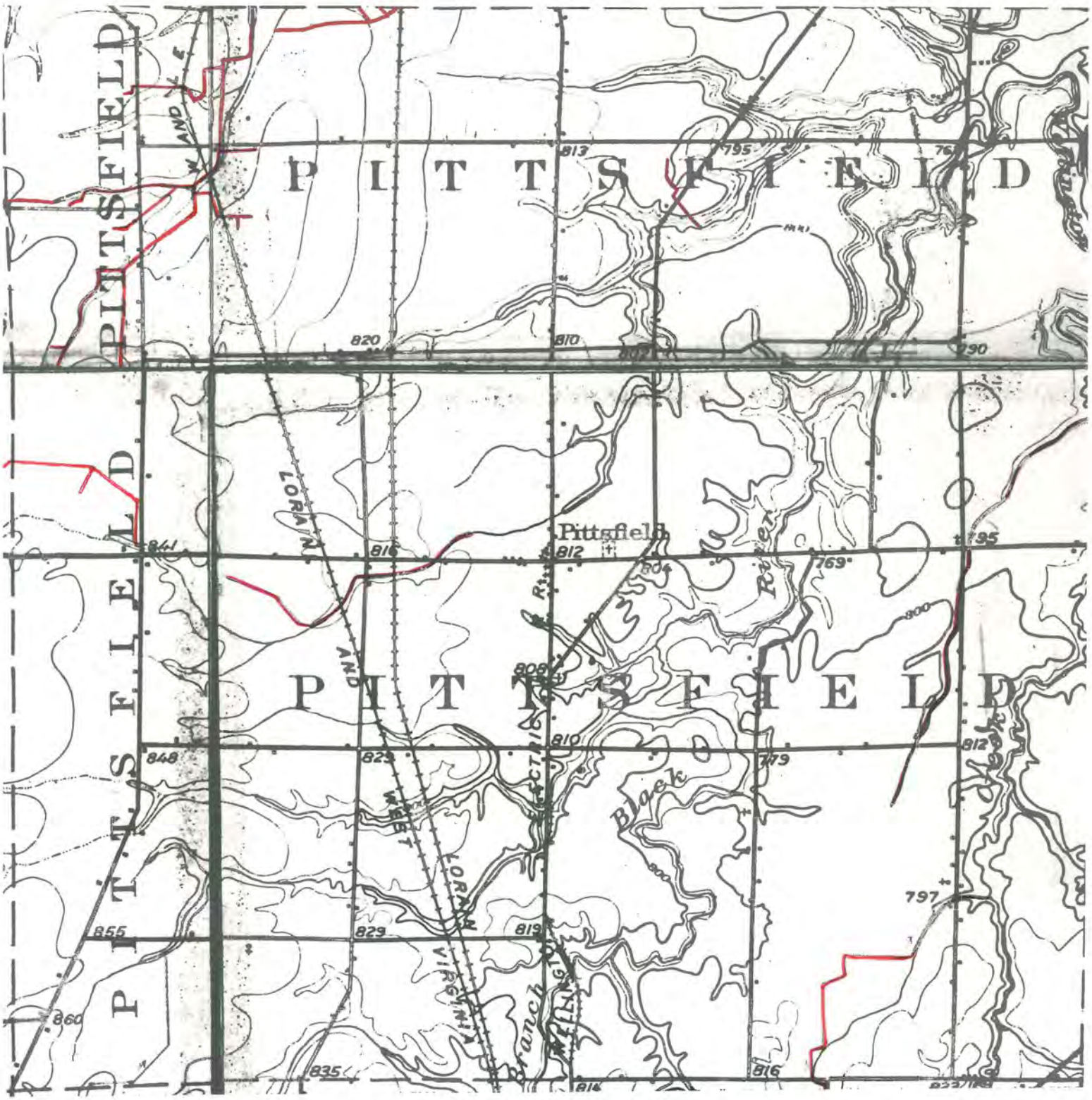

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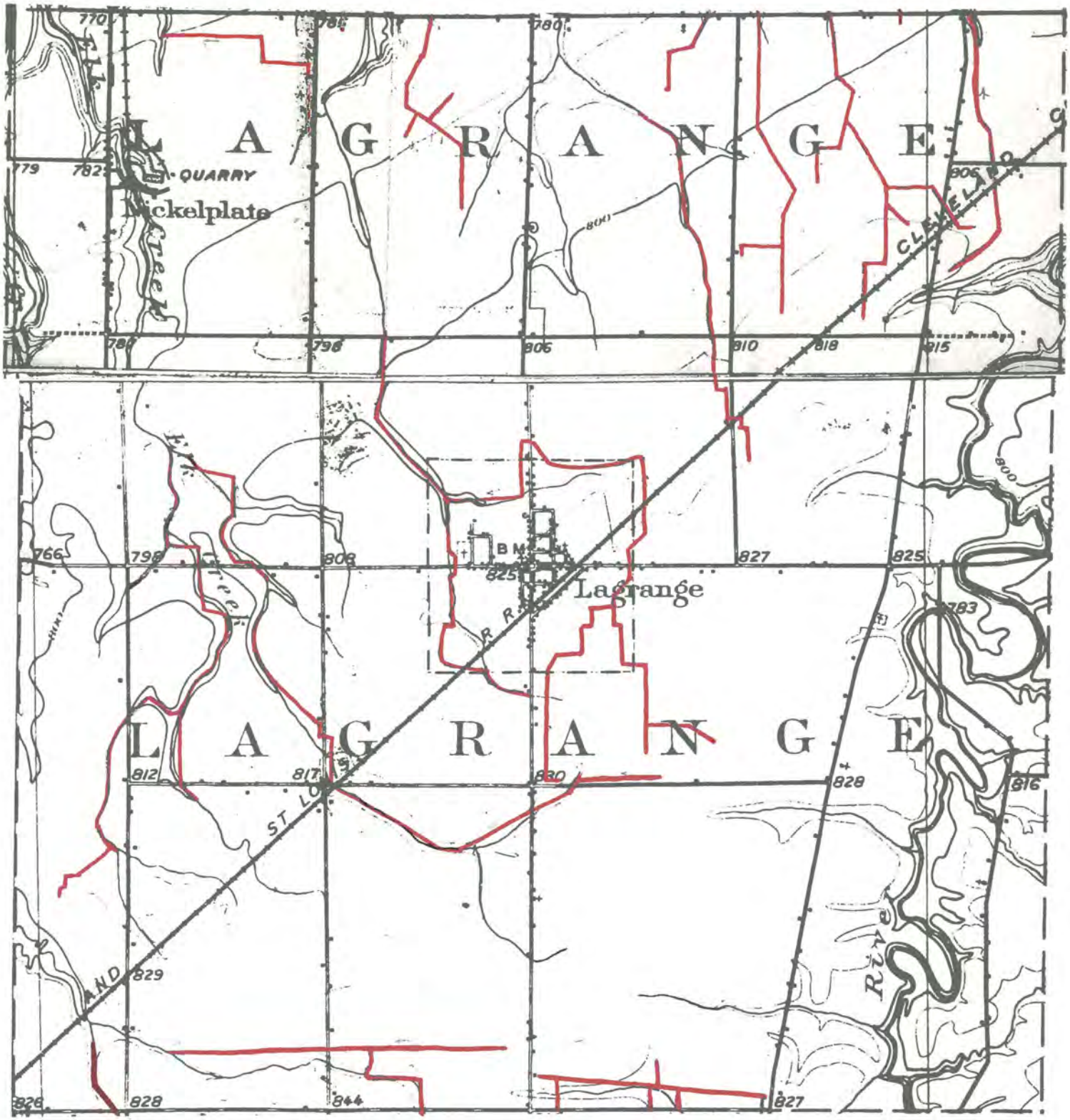
Plate XIX. Artificial Drainage Channels of Pittsfield Twp. 1946



Scale 1:42,240

Plate XX. Artificial Drainage Channels of LaGrange Twp. 1946

Scale 1:42,240

Plate XXI. Artificial Drainage Channels of Grafton Twp. 1946

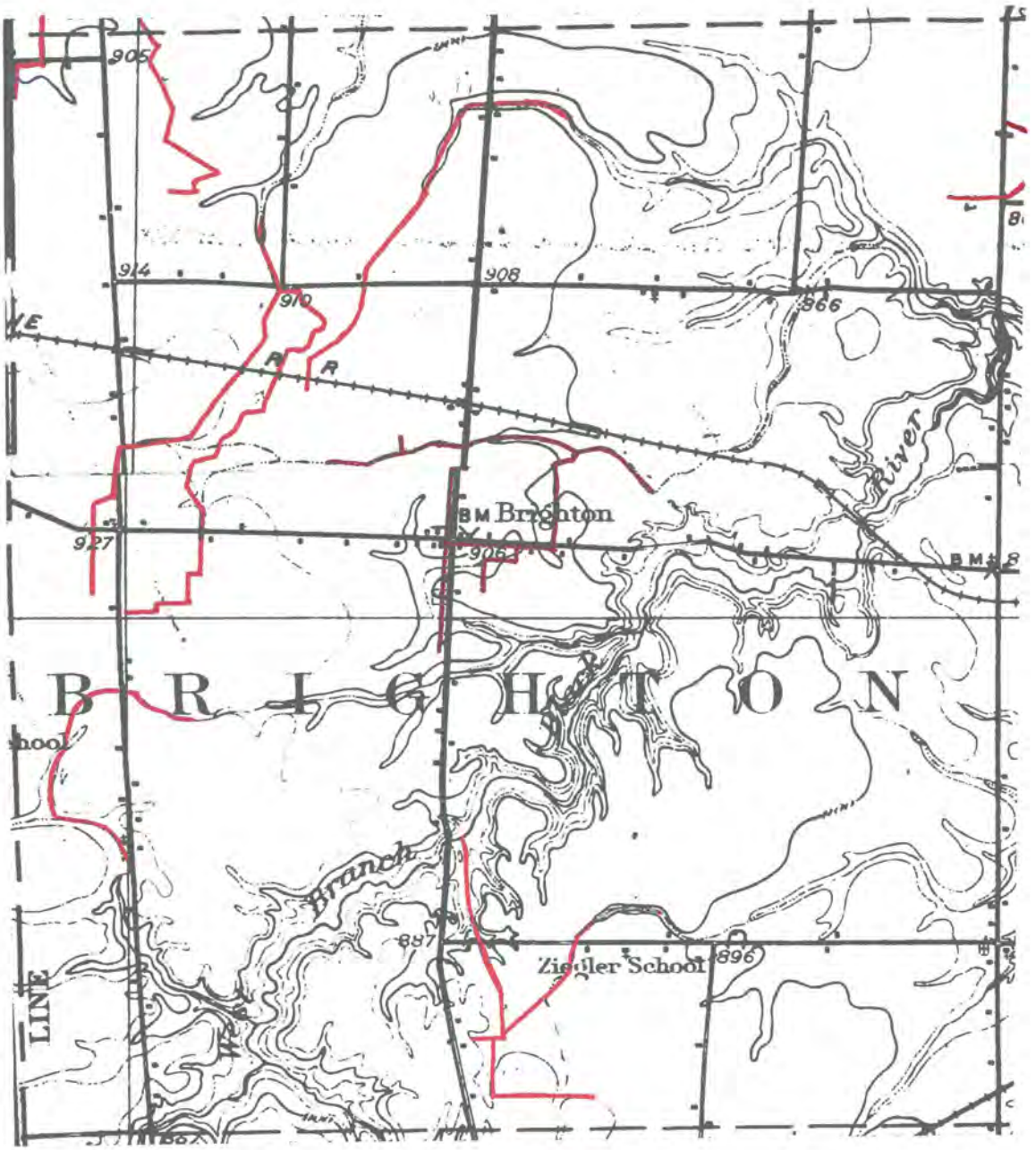


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Plate XXII. Artificial Drainage Channels of Brighton Twp.

1946

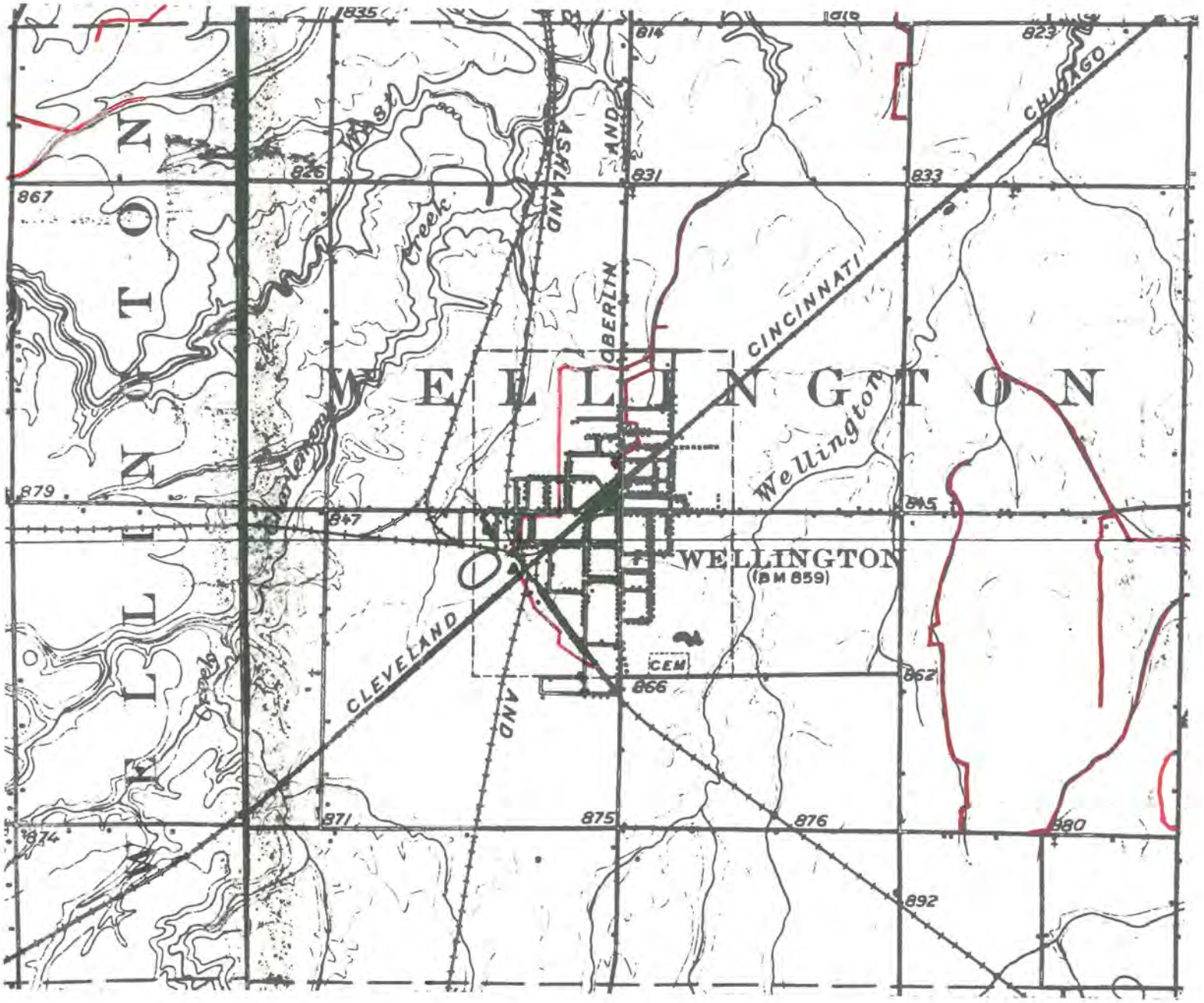

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Plate XXIII. Artificial Drainage Channels of Wellington Twp. 1946

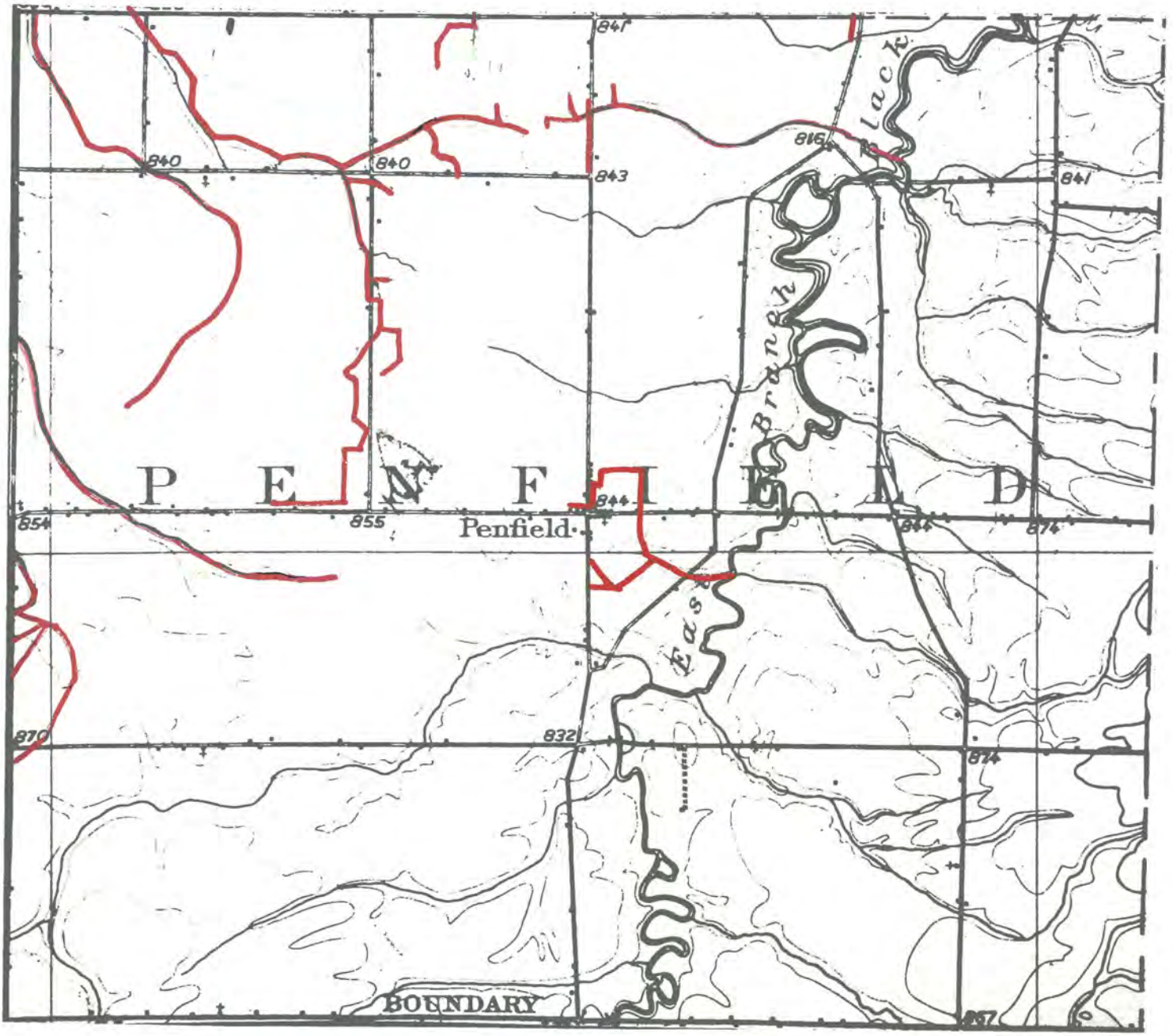

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Plate XXIV. Artificial Drainage Channels of Penfield Twp. 1946

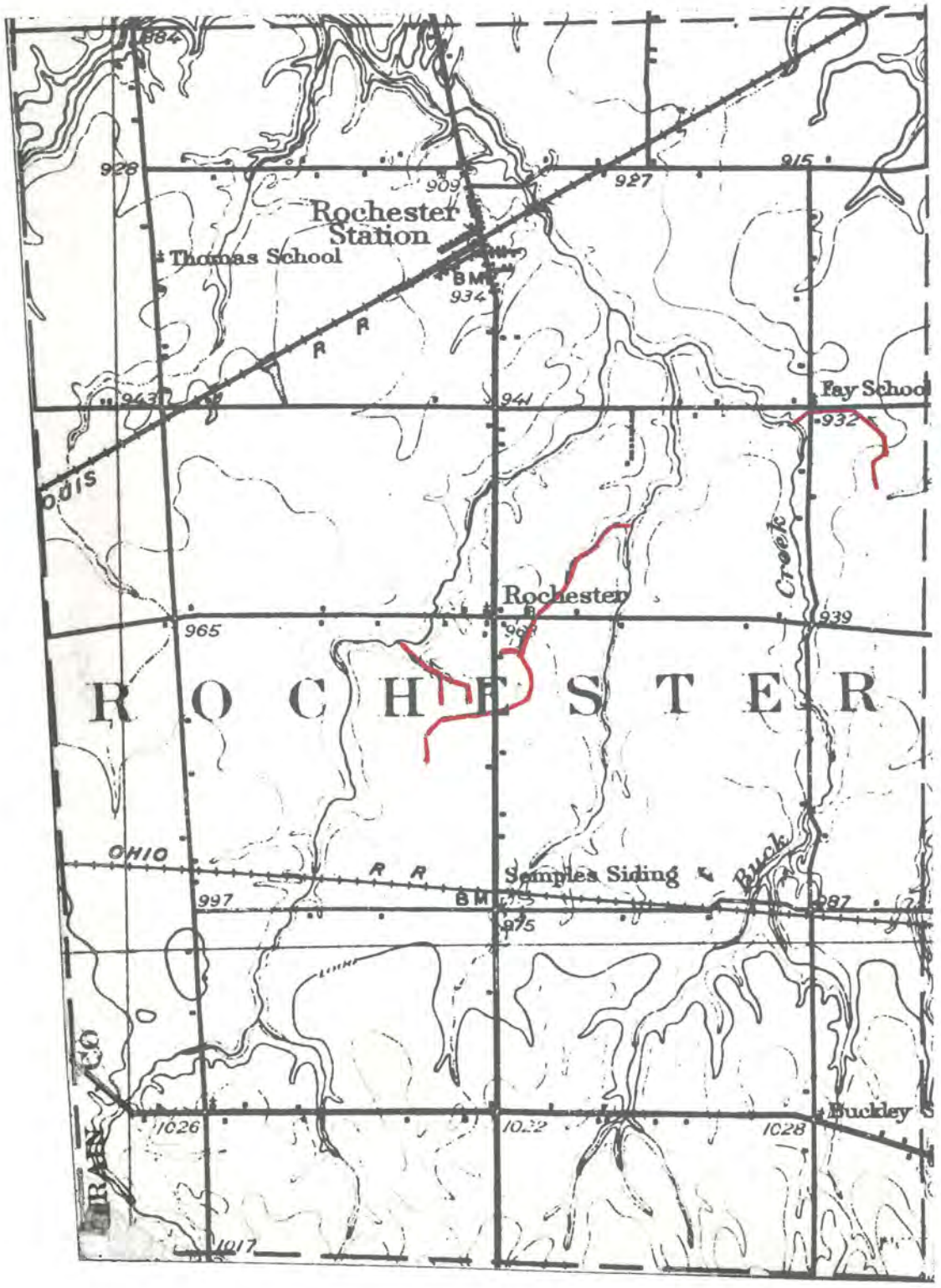

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Plate XXV. Artificial Drainage Channels of Rochester Twp.

1946

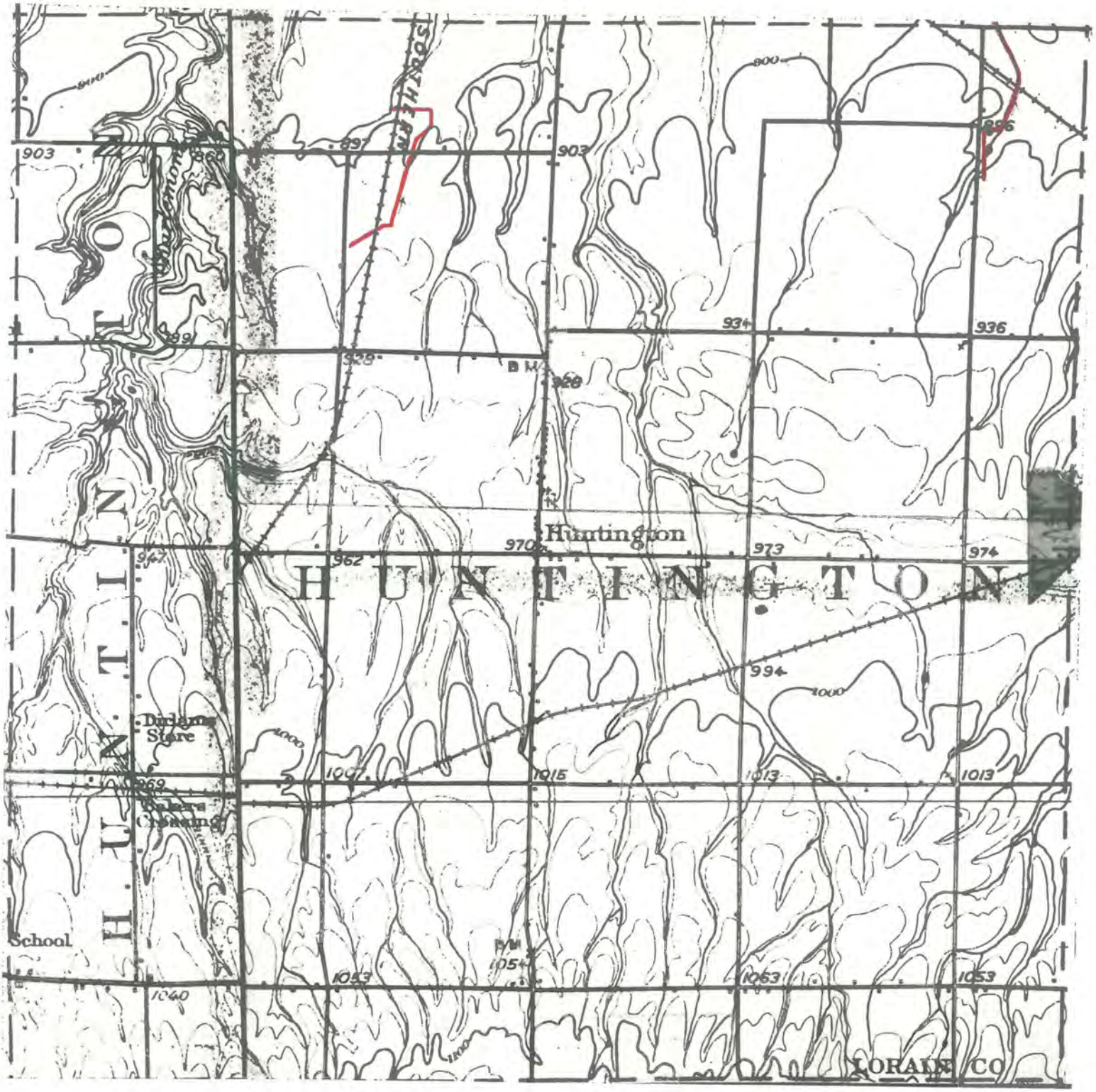

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Plate XXVI. Artificial Drainage Channels of Huntington Twp. 1946