

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—MILTON WHITNEY, Chief.

SOIL SURVEY OF NIAGARA COUNTY,
NEW YORK.

BY

ELMER O. FIPPIN, GROVE B. JONES, W. J. GEIB,
ORLA L. AYRS, AND C. W. MANN.

[Advance Sheets—Field Operations of the Bureau of Soils, 1906.]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1908.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., October 7, 1907.

SIR: A soil survey was made of Niagara County, N. Y., during the summer of 1906 at the request of and in cooperation with the Cornell College of Agriculture, the map and report to form a basis for and to supplement an orchard survey being carried on contemporaneously by the horticultural department of that institution.

I have the honor to transmit herewith the report and map covering this work and to recommend that they be published as advance sheets of Field Operations of the Bureau of Soils for 1906, as provided by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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MAP.

Soil map, Niagara County sheet, New York.

SOIL SURVEY OF NIAGARA COUNTY, NEW YORK.

By **ELMER O. FIPPIN, GROVE B. JONES, W. J. GEIB, ORLA L. AYRS**
and **C. W. MANN.**

DESCRIPTION OF THE AREA.

Niagara County is situated in the northwestern part of New York, in the angle between Lake Ontario and the Niagara River. Orleans County and a small portion of Genesee County form the eastern boundary. Tonawanda Creek separates it on the south from Erie County, in which is located the city of Buffalo.

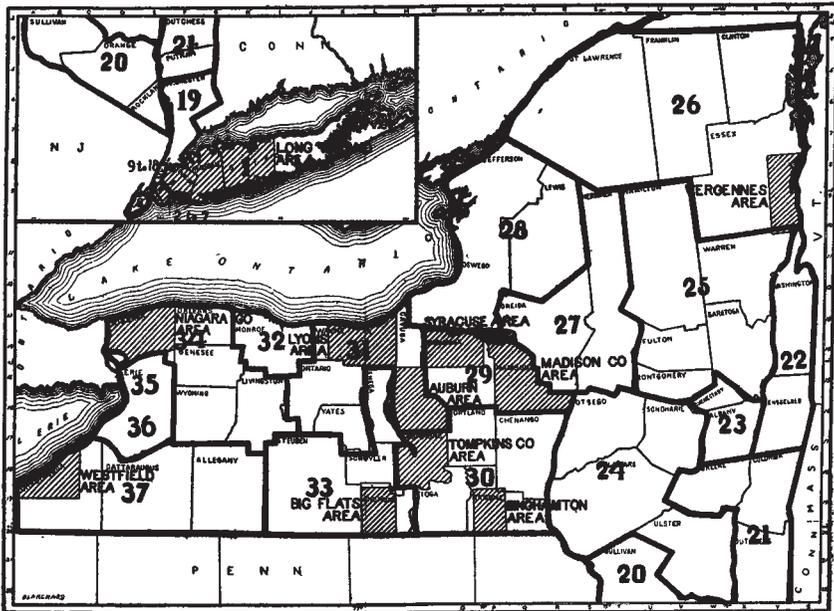


FIG. 1.—Sketch map showing location of the Niagara County area, New York.

The county is roughly rectangular in shape, and contains 349,952 acres or about 547 square miles. Viewed in its physiographic relation to the remainder of New York State, the county occupies portions of two great lake plains, which in this region are separated by a sharp change in level of approximately 200 feet. These are the Ontario and Erie plains, which extend eastward around Lake On-

tario and westward into Canada. Toward the east their difference in level becomes progressively less marked, until in Monroe, Wayne, and Oswego counties they unite in a regular slope to the lake. Toward the west their sharp distinction is maintained for many miles beyond the Niagara River. The Erie plain reaches around the southern side of Lake Erie as a narrowing rim faced by a steep slope to the highland.

To the south of the county the Erie plain has an extension of many miles to where it merges with the highlands of southern New York and Pennsylvania in southern Erie, Wyoming, and Livingston counties. The line of separation between these last two divisions is much less distinct toward the eastern than toward the western part of the State.

The best position for a bird's-eye view of the physical features of the county is opposite its center over Lake Ontario. From here the two plains, separated by a steep escarpment, may be distinctly observed. This escarpment crosses the county in a nearly east and west direction a little south of the center. In the foreground of one's view is the Ontario plain, which faces the lake as a bluff from 10 to 30 feet in height. Its width is from 7 miles in the western to 12 miles in the eastern part of the county. Its surface is generally level, with a slope of from 100 to 150 feet from the foot of the escarpment to the lake. The greater portion of this slope is in the 3 miles of country bordering the lake. South of this strip is a broad area of quite flat country several miles in width and distinguished on the soil map by the prevalence of the Clyde series of soils, which owes its origin to swampy or incipient lake conditions.

The most striking feature of the Ontario plain is a low, rounded bar of gravel that lies almost parallel with the lake shore at a distance of from 7 to 8 miles. Its elevation above the general level is from 10 to 20 feet and its width is about one-fourth of a mile. These dimensions are maintained with remarkable uniformity, and only in the vicinity of Ridgeroad is there any considerable widening or formation of spurs connecting with the main bar. It enters the county from the east and extends to within 7 miles of Niagara River with only one break, which occurs about the center of the county, where the two ends turn southward to join the lower slopes of the escarpments. The passage thus formed by the two ends leads up to the only two large canyons that notch the escarpment. Small bars of gravelly material are common north of the "Ridge," and between it and the foot of the escarpment, in the eastern half of the county, remnants of two or more gravelly ridges may be traced, forming minor bars roughly parallel to the main one.

Between the "Ridge" and the escarpment there is a level area several miles in width, except in the western quarter of the county,

in the town of Lewiston, where the gravel bar touches the main slope and practically disappears. From that point westward to the river its course is marked only by small isolated bars of gravel.

The southern limit of the Ontario plain is marked by the escarpment. This is a rather sharp northward slope which rises to an elevation of about 200 feet above the lower plain. At the western end it is almost precipitous, but grows less steep toward the east. In Wilson and Cambria towns it breaks into two slopes separated by a terrace from one-half to 1 mile in width at an elevation of 550 feet. The escarpment extends almost directly east and in the center of the county, at Lockport, is reunited into a single steep slope. Here the slope is broken by the two largest canyons that notch its face. The western one is known as the Gulf and extends southward about $1\frac{1}{2}$ miles. The other one is some 2 miles farther east, in the city of Lockport, and is much smaller. It affords a natural passage for the Erie Canal from the lower to the upper plain, and in it is the series of locks from which the city takes its name. Opposite the mouth of this canyon, at a distance of less than half a mile, is a peculiar formation consisting of a high rocky ridge with a northeasterly trend and about 2 miles in length. It reaches nearly the elevation of the upper plain and has a quite steep and rocky slope on the northern side. Its western end forms one side of the mouth of the Gulf. The southern slope is less steep and has a considerable soil covering. Past the western end is a natural channel through which the waste water of the canal is discharged, while around the eastern end is a natural river channel with a rock bottom, though now abandoned except for a small thread of water. The only other canyon worthy of notice is in the eastern part of the county, in the town of Hartland, near Gasport.

East of Lockport the slope becomes longer and less abrupt, and near the border of the county, in Hartland town, is spread over 2 or 3 miles. Near the upper limit there is generally a short, precipitous slope in which rock outcrops, and throughout the length of the escarpment the solid rock is very close to the surface, except near its lower part, where much unconsolidated material has been deposited.

Looking next at the upper or Erie plain, it is found to be less level than the lower plain. Its greatest elevation in the county is a short distance south of the crest of the escarpment, where the surface is rendered quite uneven by low, rounded ridges and knolls that have an easterly or southerly trend. The general slope is southward to Tonawanda Creek, and in that direction the country becomes progressively more flat by the gradual disappearance of the ridges and knolls mentioned above.

The general elevation in the northern part is 640 feet, and on some of the highest points 680 feet is reached, while in the southern part

the elevation is from 580 to 600 feet. The western part of the plain is more level than the eastern part.

All of the drainage of Niagara County is into the Niagara River or Lake Ontario. On the lower plain the drainage water flows in a few short streams directly into the lake. Of these there may be mentioned Johnson Creek in the eastern part, Eighteenmile Creek in the central part, and Twelvemile Creek in the west-central part, the first two having their beginning on the upper plain a short distance south of the crest of the escarpment.

The lower part of all these streams shows evidence of having been formed at a time when the run-off was much greater than at present. The main part of Eighteenmile Creek leads up to the mouth of the Gulf, and this canyon could hardly have been formed by the small stream of water which now occupies its bottom and is dry a part of the year. The channels of the streams mentioned enlarge greatly toward the lake until they become an eighth of a mile across at some points, with lagoons along the course and broad, deep mouths at the lake. These have been cut into the shale rock in a quite level country and are much larger than needed to carry the present drainage water. It is probable they owe their origin to the large volume of water discharged at the close of the glacial period.

With the exception of the small amount of water flowing directly into Lake Ontario, the drainage of the Erie plain is into Tonawanda Creek, which empties into the Niagara River. This creek is an extremely sluggish stream with a very tortuous course and a very narrow flood plain. The immediate channel, however, is quite deep. Its tributaries in the county are few in number and small in size. In the western part Sawyer and Bergholtz creeks exhibit the same enlargement in their lower courses as seen in the streams on the lower plain.

The county is thickly settled, and in 1900 had a population of 74,961. There are no large cities, but a number of small ones. These are Lockport, in the central part on the escarpment, with a population of 17,000; North Tonawanda, at the mouth of Tonawanda Creek, 9,000; Niagara Falls, 19,000, and Lewiston, on the Niagara River at the foot of the escarpment, 700.

Besides these there are a number of villages. On the lower plain these are Barker, Somerset, Wilson, and Youngstown, named in order from east to west along the lake; and a little farther inland are Johnson Creek, Newfane, and Ransomville. Along the escarpment are Middleport and Gasport, and on the Erie plain are Royalton, Pendleton, Sanborn, and Bergholtz. The city of Buffalo is only 6 miles from the southern margin of the area.

The country districts are thickly settled, particularly in the northern and eastern parts of the county, where fruit raising is most

largely developed. Farms are generally of small size, averaging 70 acres, and farmhouses occur at frequent intervals along the roads, which are generally on a rectangular plan and run north and south and east and west, but do not occur on section lines or at regular intervals.

Along certain of these roads the settlement is especially thick. Some of these are the Lake road, near Lake Ontario; Hess road, leading north and south in central Newfane town; Creek road, on the east side of Eighteenmile Creek; Ridge road, on the gravel ridge near the southern part of the Ontario plain, along which settlement is especially dense; the road along the foot of the escarpment, and lastly the Chestnut Ridge or mountain road along the northern border of the upper plain.

Nearly all of the earliest settlers were of English extraction and came from the eastern part of the State or from the New England States. A few were from New Jersey. At the present time their descendants occupy the northern half or two-thirds of the county. The southern part is largely occupied by people of German descent. Wolcottsville in the eastern part and Bergholtz in the western part were settled by communities of German immigrants, the land having been secured for them in advance of their coming. The industry and frugality of this stock has been a large factor in developing the heavy clay soils of the southern part of the county.

The county has an excellent school system. Some of the northern towns have combined the rural districts into union schools, which also give instruction above the eighth grade. The villages and cities have excellent high schools. Telephones are in very general use throughout the rural districts. The country roads have been macadamized to only a very small extent, though the recent State appropriation for road improvement is being taken advantage of and a number of stretches of road have been put in a better condition.

The gravelly and sandy roads in the northeastern part of the county remain in pretty good condition through the year, and the Ridge road is always in excellent condition, except for dust and sand in summer. But where the Clyde series of soils crosses the roads of the lower plain, and off the Dunkirk loam and Dunkirk silt loam on the upper plain, the roads may become almost impassable from deep, stiff mud.

The New York Central Railway has two lines across the county. One of these—the Rome, Watertown and Ogdensburg—serves the larger villages on the lower plain and touches the Niagara River at Lewiston, where it turns south to Buffalo. The other is a main line of the system between Rochester, where it connects with the through eastern line, and the Falls. East of Lockport its course is at the

foot of the slope through the densely settled fruit region. To the west it extends across the clayey Erie plain and at Lockport Junction gives off a branch to North Tonawanda and Buffalo. Both lines are well equipped and afford excellent local and through service, this being particularly true of the Niagara branch.

In addition to steam roads there is the Buffalo and Lockport Electric line, which passes through North Tonawanda, and extends to the lake at Olcott Beach and to Niagara Falls. This affords a half-hour passenger service in summer and carries express, including fruit. The Erie Canal, which crosses the county through Middleport, Lockport, and North Tonawanda, is not a factor in transportation in the county, its freight being mainly of a through character between its terminals.

Markets for produce are good. The local demand can not be considered large, though it is very important, and with the development of the city of Niagara Falls it is likely to increase. The region has become widely known for its fruits, particularly for apples, pears, and grapes, and in the harvest season it is visited by buyers from many parts of the country. In addition to what may be termed the foreign market there are the cities of Buffalo and Rochester and other important cities on the New York Central Railway, even as far away as New York City, which receive truck, small fruit, grain, and animal products from Niagara County. The villages along the railroads in the fruit-growing sections become intensely active in the fruit and vegetable harvesting season and ship many carloads of such produce daily. One of the most active of these is Gasport, which is central for a large region. It is said to have shipped as many as 30 cars a day in the busiest season.

Market facilities are further extended and steadied by a large number of storage plants for all kinds of produce adapted to the treatment. Each of the villages in the fruit region has from one to several of these storage plants, with a capacity of thousands of barrels. Some of these are equipped with icing plants, known as chemical storage, while the others depend upon the regulation of ventilation. In the city of Lockport there is chemical storage for about 130,000 barrels, besides common storage for a much larger amount of produce.

There are several canning factories and a number of plants equipped to dry fruit, chiefly apples. One of the largest canning factories is at Middleport and uses pears, which are the leading fall fruit handled, peaches, plums, cherries, raspberries, blackberries, strawberries, gooseberries, currants, peas, beans, corn, and tomatoes, besides manufacturing considerable amounts of jam and jellies in winter from surplus of fruit for which there is only time in the harvest season to cook for preservation. Other stations ship fruit and vege-

tables to factories at Brockport and Rochester. All these accessory market facilities increase the independence and security of the producers by insuring an outlet and by steadying and regulating prices, and thus add to the stability of such business interests.

CLIMATE.

The mean annual temperature is about 47.5° F. The maximum temperature recorded is 99° at Lockport, which is 1° above the maximum recorded at Appleton. The minimum temperature recorded is -12° F. at Appleton, which is 2° below the minimum record at Lockport. The mean monthly temperature range is from 24.3° in February to about 70° in July.

The development of the fruit industry in the county has led to a close observation of the climatic conditions in different parts of the area, and it is to be regretted that there are not more numerous records of temperature, frost, and precipitation. Many statements of variation in frost prevalence and severity are current among fruit growers. The presence of Lake Ontario is generally conceded to exercise an ameliorating effect on the temperature of the lake shore country. Turner says, in Tarr's Physical Geography of New York State, that the waters of Lake Ontario are from 10° to 15° warmer in winter and cooler in summer than the air over the adjacent land. This must modify the land temperatures near by.

The temperature tables exhibit this effect to a limited degree. Appleton is within 2 miles of the lake at an elevation of 340 feet, and Lockport is 12 miles from the lake at an elevation of 620 feet. While the mean annual temperatures at the two places are within 1° of each other it may be observed that in the months of April and May Appleton is 2° cooler than Lockport, and in November it is 1.2° warmer. In driving toward the lake in summer, this modifying influence may be distinctly felt in the more cool and moist breeze. The general effect is greater upon the maximum than upon the minimum temperatures.

Records are available for Fort Niagara, which is on the immediate lake shore, at its junction with Niagara River. Maximum temperatures in winter and spring are from 2° to 5° F. below those at Appleton or Lockport, with the average maximum greatest at Lockport. More noticeable is the fall effect. Beginning about September the monthly mean temperature is from 1° to 5° F. higher at the lake stations than on the escarpment. This indicates a more gradual change of temperature from summer to winter, which insures a more perfect maturity of fruit twigs and buds. Perfect maturity

has been shown to be a very important factor in resistance of plants to low temperatures. This, together with lower maximums in winter, which prevent premature swelling of the buds, protects fruit from excessive winter injury.

The average date of the last killing frost in spring is in the last four days of April, and the first in fall occurs about the 16th of October. This gives a growing season of over one hundred and seventy days. It may be noted from the accompanying table that frost occurs three days later at Appleton near the lake than at Lockport on the escarpment. Injurious frost sometimes occurs a month later on the lake shore than in the lower part of the county, as shown by official records. Mr. W. V. Corwin states that the same variety of wheat ripens a week later near the lake than it does 7 or 8 miles inland.

Other variations are reported. The country along the foot of the escarpment is said to be several days earlier for crops and more free from frost than the low, flat country to the northward. This may be due largely to the poorer drainage of the latter, which is a region of rather wet lands where the Clyde series of soils prevails. In the clay region south of the escarpment some difficulty is experienced in maturing corn on the heavy soils—Dunkirk clay and Clyde clay.

The annual precipitation is a little over 32 inches, one-half of which falls in the five months from May to September, inclusive. During this growing season of crops there is 1 inch less rainfall at Lockport than at Appleton. Snowfall, on the other hand, is greater at Lockport, where the average for eight years is 60 inches as against 46 inches on the lake shore. The atmosphere in the latter region has much the higher relative humidity, as shown by the fact that in winter 43 per cent of the days are cloudy as compared with 32.5 per cent at Lockport, while in summer only 10 per cent of the days are cloudy near the lake as compared with 19 per cent near the top of the escarpment. The annual percentages of cloudy or partly cloudy days at the two observation stations are 66 and 63, respectively. This is considerably above the average for the State.

The prevailing direction of the wind is westerly, chiefly southwesterly. It is more variable at Appleton than at Lockport, and in spring is frequently easterly at the former station. Fog is most frequent along the escarpment, having been reported eleven times in eight years at Lockport as against twice at Appleton. On the other hand, sleet and hail appear to be more common near the lake, sleet having been reported twenty-one times and hail fourteen times in eight years, from 1894 to 1902, at Appleton, as against sleet nine and hail four times at Lockport for the same period.

The following tables, showing the normal monthly and annual temperature and precipitation, and the dates of last killing frost in

spring and of the first in the fall, at Appleton and Lockport, indicate fairly well the climatic conditions in Niagara County :

Normal monthly and annual temperature and precipitation.

Month.	Appleton.		Lockport.		Month.	Appleton.		Lockport.	
	Temper- ature.	Precip- itation.	Temper- ature.	Precip- itation.		Temper- ature.	Precip- itation.	Temper- ature.	Precip- itation.
	°F.	In.	°F.	In.		°F.	In.	°F.	In.
January	26.3	2.55	25.2	2.49	August.....	66.7	3.11	68.3	2.68
February	24.3	2.14	24.4	2.54	September ..	61.4	3.24	62.3	3.03
March	32.4	2.02	33.7	2.25	October	50.0	2.35	51.7	2.47
April	44.5	2.05	46.4	2.21	November ..	40.2	2.79	39.0	2.57
May	54.8	2.91	56.9	2.68	December...	29.8	2.53	30.2	2.57
June.....	64.7	2.79	66.6	2.49	Year ..	47.1	32.73	48.0	32.26
July	69.6	4.25	70.7	4.28					

Dates of first and last killing frosts.

	Appleton.		Lockport.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1898	May 6	Oct. 28	Apr. 9	Oct. 27
1899	Apr. 17	Oct. 2	Apr. 17	Oct. 3
1900	May 7	Oct. 20	May 4	Oct. 17
1901	Apr. 20	Oct. 7	.....	Oct. 18
1902	May 11	Oct. 10	May 11	Oct. 10
1903	May 2	Oct. 27	May 1	Oct. 27
1904	Apr. 22	Oct. 15	Apr. 22	Oct. 7
Average.....	Apr. 29	Oct. 16	Apr. 26	Oct. 16

AGRICULTURE.

While the territory embraced within Niagara County was among the first in the Lake States to be visited by white men, its bona fide settlement did not begin in earnest until in the opening years of the nineteenth century. The waterway leading up the St. Lawrence and through the Lakes by way of Lake Ontario, the Niagara River, and Lake Erie brought adventurers into the region in the latter part of the seventeenth century or earlier. The obstruction of falls in the water passage between the Lakes necessitated a portage of all passengers and freight, and the trade with the Indians of the interior developed a thriving business for a few settlers in this form of transportation. Even earlier the strategic importance of the river as a key to the governmental and industrial situation became apparent to the nations interested in the region, and led to repeated attempts at fortification and to many sanguinary encounters on the territory along the Niagara River. The greater part of the population prior to 1800 was connected with the garrisons, and no definite attempts to follow agri-

culture were made. But the military and trading activities involving the transient passage of a considerable number of persons through the county focused attention on the natural resources of the region and spread the knowledge of its advantages. In addition to the waterway two of the leading ancient Indian trails, which later became white men's trails, led through the county from the east to the fortifications. The Indians termed it "the land of the Basswood."

In 1802 the first settlement outside of the river bank and for agricultural purposes was made on the lake shore under the shadow of Fort Niagara.

All the territory in Niagara County, except a strip a mile wide along the Niagara River, was embodied in the Holland purchase, which passed from the possession of the State of Massachusetts by way of Robert Morris in 1793. After extinction of the Indian title to the land, by agreement with the Seneca Indians in 1799, the land was rapidly surveyed and opened for settlement. From 1802 until 1812 settlement was comparatively active and was pretty generally distributed on the drier parts of the county. The first settlements were on the lake shore, the Ridge road, the Mountain ridge, and along the Niagara River. Some selections were also made along Tonawanda Creek. For a number of years settlement was chiefly confined to these areas, the excessively marshy condition of the intervening lowland defying subjection. The production of cranberries at that time yielded some revenue.

Upon the outbreak of the war of 1812 the exposed and dangerous position of the region led to a general exodus of the settlers, and it was a number of years before settlement again became active. The settlers bought their land from the Holland Land Company, paying from \$2 to \$5 an acre. The higher, drier land bore a heavy growth of broad-leaved trees and some hemlock. Among the former the valuable species were hard and soft maple, black walnut, white and red oak, basswood, tulip, poplar, hickory, elm, beech, and chestnut. The swampy lowlands were a tangle of vegetation with large trees of elm, black ash, cedar, and tamarack, and bushes of alder and huckleberry. Much of this country was said to be open ponds in the early days.

The first crops grown were those which would meet the simple needs of the settlement, there being no outside exchange worth considering. Wheat, oats, corn, and potatoes were the early crops. An important industry was the production of "black ash salts" and the reduction of potash from the surplus timber, this frequently bringing in the first money of the settlers.

The completion of the Erie Canal, in 1825, gave a great impetus to settlement in the county, as is attested by the number of villages along its course. It provided a ready means of transportation, per-

mitted a flow of trade between the West and the East, and stimulated industry. Many laborers employed on the canal remained to enter business. Products hitherto without a market could now be produced in abundance, a condition which relieved much of the former stagnation. This fact is reflected in the crops grown. In the several decades following the completion of the canal the leading crop was wheat, which was shipped to eastern markets. The town of Wheatfield was named from the large production of wheat in the southwestern part of the county. Many potatoes were also grown. In 1840 and prior thereto the leading crops in order were wheat, potatoes, oats, corn, barley, buckwheat, peas, beans, and flax.

Three times as many neat cattle, nearly as many cows, and more than twice as many sheep were reported in that year as in the census of 1900, and at that time the area of improved land was only a little over 50 per cent, as against 83.7 per cent in 1900. All these gave products suitable for shipping by canal. Large storage buildings for grain were provided at the villages, and there were similar shipping stations at Olcott and other points on the lake. The canal also gave an outlet for lumber and permitted a rapid reduction of the timber, which was one of the leading industries that later made way for farming.

Stock raising was largely engaged in until a decade after the civil war, when western competition became severe. Sheep raising assumed relatively greater importance prior to and during the war, as a result of high prices secured for wool, but by 1870 it had declined decidedly.

Grain farming continued the mainstay of the farmers until as late as 1880. During the period between 1860 and 1870 insect injury led to a reduction of the acreage of wheat. Oats have always been one of the most important crops. Barley has also been important, but its acreage seems to have greatly decreased since 1890. The maximum production reported was in 1880. It is a crop adapted to a short season, and doubtless was found very useful on the wet land. With the extension of artificial drainage its importance has relatively decreased. Buckwheat attained its maximum production in 1860, when the yield was 49,892 bushels. Pulse crops have also been important and have undergone a change in character from 1845, when 84,626 bushels of peas were produced, to 1880, when 84,432 bushels of beans were reported out of a total of less than 90,000 bushels of such crops. The largest production of corn was in 1880, when 833,226 bushels were reported.^a

Hay has always been, as it is now, in the lead in total acreage. Timothy and clover form nearly all of the hay. On the wet lands

^a The yields are for the year preceding the year of the census report.

of the Clyde series, particularly in the southern part of the county, alsike has been substituted to a large extent for red clover, it being better adapted to moist conditions.

The area and average production per acre of the leading field crops of the county for different decennial years are given in the following table:

Acres and production of chief farm crops in Niagara County, N. Y.

Year.	Wheat.			Corn.			Oats.		
	Acres.	Yield per acre.	Total yield.	Acres.	Yield per acre.	Total yield.	Acres.	Yield per acre.	Total yield.
1900.....	40,614	18.6	.....	22,476	30.5	.....	34,286	34.1	.....
1890.....	39,571	18.0	.....	13,574	29.3	.....	30,385	29.8	.....
1880.....	46,644	18.6	.....	22,606	36.9	.....	21,386	35.1	.....
1860.....	.....	.....	^a 133,862	.....	.....	^a 731,907	.....	.....	^a 625,535
1845.....	.....	.....	^a 713,318	.....	.....	^a 188,166	.....	.....	^a 292,099

Year.	Hay.			Barley.			Beans.		
	Acres.	Yield per acre.	Total yield.	Acres.	Yield per acre.	Total yield.	Acres.	Yield per acre.	Total yield.
1900.....	64,689	1.1	.....	4,649	26.1	.....	3,980	11.0	.....
1890.....	63,793	1.3	.....	17,436	22.5	.....	.....	.....	.....
1880.....	47,272	1.1	.....	22,732	21.8	.....	.....	.....	.....
1860.....	.....	.....	^a 41,427	.....	.....	^a 282,659	.....	.....	.....
1845.....	.....	.....	.....	.....	.....	^a 58,340	.....	.....	^a 2,185

Year.	Potatoes.			Rye.			Buckwheat.		
	Acres.	Yield per acre.	Total yield.	Acres.	Yield per acre.	Total yield.	Acres.	Yield per acre.	Total yield.
1900.....	5,951	88.0	.....	542	17.7	.....	353	12.7	.....
1890.....	4,657	68.0	.....	1,224	15.7	.....	1,360	15.4	.....
1880.....	4,168	105.0	.....	501	14.9	.....	971	13.0	.....
1860.....	.....	.....	^a 549,404	.....	.....	^a 69,428	.....	.....	^a 49,892
1845.....	.....	.....	^a 333,658	.....	.....	.....	.....	.....	^a 20,101

^a Figures for 1860 and 1845 are total yields in tons and bushels.

A crop rotation is generally practiced, the succession being varied somewhat according to the soil and climatic conditions. Sod land is plowed for the cultivated crops—corn, potatoes, and beans. These are followed by oats and wheat, and in the latter are seeded grass and clover, which occupy the land for from two to four years. Manure is applied to the sod and to the oat stubble. The method of grass seeding varies with the farmer. Clover is always seeded in the spring and timothy more often in the fall. This represents the rotation on the lighter soils like the Dunkirk loam, Dunkirk silt loam, Clyde loam, and Clyde fine sandy loam. These three cultivable crops

represent the greater part of the plowed land. On the heavy soils, like the Dunkirk clay, Dunkirk clay loam, and Clyde clay, the area of cultivable crops in rotation is greatly reduced, much of the sod being put directly in oats. This is because corn, beans, and potatoes have not succeeded well on the heavy soils. By the judicious and generous use of farm manures the production of corn and beans may be increased and their area extended, which will improve the rotation. Roots may well be introduced as a cultivated crop where they can be utilized. On the heavy soil several crops of oats and wheat are sometimes grown in succession, and the soil is recuperated by an occasional year of fallow. On the lighter soils this is not practiced.

The number of live stock on the farms since 1870 has been considerably less than prior to that time. This applies to all classes except milch cows, in which there has been a small increase. While animal production has decreased, its place is being taken by more exclusive grain farming and by fruit growing. The change in character of farming has been less in the southern heavy clay soils than in the northern two-thirds of the county. Many cattle are still kept in the clay region, dairying is becoming more prominent, and silos are not uncommon. In this section corn can better be produced for silage than for grain. A number of years ago a creamery was established at the Rapids on Tonawanda Creek, but it is said to have failed because a sufficient supply of milk could not be secured. The number and value of live stock on farms in the last fifty years are reported as follows:

Number and value of live stock on farms in Niagara County, N. Y.

Year.	Horses.	Work oxen.	Milch cows.	Neat Cattle.	Sheep.	Swine.	Total value of live stock.
1850.....	9,510	2,716	9,832	11,646	59,093	20,504	\$1,088,304
1860.....	11,712	980	12,691	12,528	79,731	21,967	1,818,502
1870.....	12,218	154	11,594	7,798	53,362	11,964	2,746,917
1880.....	14,665	25	12,171	8,635	33,331	17,258	2,100,907
1890.....	16,488	37	13,389	6,191	38,448	21,047	2,330,950
1900.....	14,585	0	13,758	8,491	37,160	17,110	2,089,585

In the northern and central parts of the county attention on most of the farms is given very largely to fruit growing. The business of fruit production has been developing for more than half a century, until now this section exhibits some of the best fruit farms in the Eastern States. The first plantings of fruit were for cider and home purposes, their marked success leading to the extension of orcharding on a commercial basis. In 1813 Jairus Rose planted 2

acres to apple seeds in the southwestern part of the town of Cambria and sold the trees at 12 cents each. This was the first nursery in the county. The years from 1825 to 1850 are called the early apple planting period. Many of these seedlings were subsequently top-grafted. These trees began to come into bearing from about 1845 to 1860 and produced a surplus of fruit, which led to its being marketed and the subsequent commercial development of the enterprise. Some idea of its extent at that time may be gained from the fact that in 1850 the value of orchard products was placed at \$32,349. It is now considerably above \$1,000,000 annually. In 1860 Mr. John W. Shafer, of Gasport, bought 16,000 barrels of fruit,^a representing practically all that was grown in Hartland, Royalton, and a good part of Somerset, three leading fruit-producing towns. In 1870 the same man erected the first cold-storage plant. The success which the early plantings of apples attained led to a large increase in the acreage from 1860 to 1880, which forms the basis of the present production. In 1900 the total number of trees was 924,086. Apples having led the way, about 1875 the planting of peaches, pears, plums, and other fruit became active. With the great increase in the number of trees and in the variety of fruit insect and fungus enemies also increased, and by 1890 were a very serious menace to the fruit industry. The "yellows" and "little peach" are prevalent, and in 1900 the San Jose scale appeared. The introduction of insecticides and fungicides, 1890-1895, and their use as sprays assured the continuance of the industry. Now nearly every orchard is properly equipped and regularly sprayed, and some of the most modern apparatus is in use. The use of sprays has also been coincident with a great improvement in the care and management of orchards. Careful pruning and cultivation have increased the grade and stability of production.

Grapes have been grown from the beginning of settlement. In 1872 the Niagara grape was originated in the suburbs of Lockport, on the Dunkirk loam soil, by Mr. C. H. Hoag, by crossing the Casidy as female with the Concord as male. The former is a white grape, the latter blue, and from their hybrids the original stock of the Niagara grape was selected. Large vineyards occur in the county, particularly on the escarpment west of Lockport on the Dunkirk loam and Dunkirk clay loam soils, which is said to be a section of relatively low rainfall. The Concord and Niagara are the leading varieties, and the Delaware is said to be adapted to the conditions.

The variety of fruit grown is great, and the success attained is due in no small measure to the climatic influence of Lake Ontario. Since the winds are westerly and southwesterly, the effect of Lake Erie may

^a Souveigneur History of Niagara County.

also be considered, as well as the topographic conditions. The lake shore and the mountain are considered the most desirable locations. The soil also has a strong influence, and an important relation may be traced between the success of varieties of fruit and the soil. The country along the Lake road, Ridge road, upper and lower mountain road, and some others is thickly set with orchards. Apples are generally distributed and succeed best on the Dunkirk loam, though also grown with much success on the silt loam, fine sandy loam, and gravelly sandy loam of the Dunkirk series. The apple belts correspond closely to these soils. On the loam ridges of the southern part of the county very good apples are produced. The leading varieties, in order of quantity, are Baldwin, Rhode Island Greening, Golden Russet, Northern Spy, King, Maiden Blush, and Twenty Ounce. The last named is considered by some practical men to be better adapted to the lighter soils than the other varieties enumerated. The first four furnish nearly all the commercial apples, the Baldwin being much in the lead.

Peaches are confined more closely to the lake region, particularly in the eastern part of the county, and to the river region in the western part; and while giving best results on those soils mentioned for apples will succeed on lighter soils. Pears and plums are mostly grown on the loam and clay loam soil along the escarpment. Cherries succeed best and are mainly grown along the Ridge road on the gravelly sandy loam. Quinces, apricots (sparingly cultivated), and prunes do best and are grown most extensively on the loam and clay loam along the foot of the escarpment.

All the common varieties of small fruit are grown on all but the heavy soils in every part of the county, but are most extensively produced in the vicinity of the Ridge road, as are also muskmelons, near the village of Hartland.

According to the Twelfth Census, the number of trees and vines of the principal fruits was as follows:

Number of trees and vines and total value of fruit in Niagara County, N. Y., in 1899.

Number of trees:			
Apple	924,086	Grapevines	602,421
Peach	554,107	Small fruit, acres	900
Pear	388,472	Value of orchard products...	\$1,078,042
Prune and plum.....	184,133	Value of small fruits.....	\$66,726
Cherry	33,282	Acreage of nurseries	532
Apricot	444		

As a rule the orchards are carefully pruned and generally well cared for. Many of the purely commercial orchards are thoroughly cultivated, and there appears to be a marked increase in this practice. The color, flavor, and keeping quality of pomaceous fruits are improved by these practices. These fruits do better on the well-drained

loams than on the sandy loams. Manure and fertilizers are applied to many orchards and, in a few, vegetable mulches are used. A fundamental requisite in the minds of successful growers, after spraying, is thorough cultivation, as well as drainage and careful pruning. Such intelligent management, if begun in time, will generally transform an unsuccessful into a successful orchard.

Fruit is sold almost exclusively through agents or to buyers who at the beginning of the fruit season come into the region, often from long distances. The value of the fruit is sometimes estimated on the trees, but apples and pears are more commonly sold by the barrel and small fruits by the basket. The choicest fruit is shipped to the city market, while that of inferior grade is sent to the dry houses, cider mills, or preserving plants.

To meet the demand for packages a large number of cooperage and crate factories are distributed throughout the fruit-growing sections. There are a number of nurseries in the country centering around Lockport that have an aggregate area of considerably over 500 acres. No systematic plant breeding has been practiced.

The recognition of the adaptation of crops to soils has been more perfect in fruit growing than in grain farming. Tree fruits are seldom set on the heaviest soils or on those that are naturally poorly drained, though many orchards would be improved by more perfect drainage. Within the lighter soils the adaptation of apples is not recognized, nor is there much definite information as to the adaptation of varieties to particular soils. Peaches and cherries are put on quite light soils more often than other fruit, while pears and plums are more generally set on heavy soils.

Corn and beans are not considered well adapted to the heavy clays, though both find some place on them. On these the grains, hay, and pasture find first place. Alsike clover has been found better suited to wet land than red clover. Corn and beans are mostly grown on loam and heavier sandy loam soils, and potatoes on well-drained soils of the same class.

On all the heavier soils plowing is rather shallow—from 4 to 6 inches. A considerable part of the plowing is done in the fall. To facilitate drainage the land is usually plowed in beds from 8 to 10 paces wide, with a deep dead furrow between, and after the crop is planted these are connected by other drainage furrows along the lowest lines. With the exception of a very few farms only surface drains are in use. Tiles are but little used on the clay soils. Drainage being difficult because of the level surface and distance to outlets, a number of large drainage ditches have been constructed. The cost of these is assessed against the land benefited in proportion to the benefit derived. These ditches are not sufficiently numerous, and, as a

result of poor drainage, heaving of winter crops is severe. The poorest drained areas remain in timber and pasture.

Manure is generally conserved and applied to the plow land usually in late summer and fall. It is distributed in small piles and then spread by hand just before plowing. Manure spreaders are coming into use.

The cultural methods are generally more thorough in the fruit section than in the grain-farming section. In the southern part of the county many of the farms contain some of the Dunkirk loam, and on this type considerable orchards often find a place. Mixed farming is very generally practiced, fruit being a specialty. Not many farms are given up entirely to fruit growing. On a few of the small farms fruit growing is combined with market gardening, and as far out as Lockport some of the products are hauled by wagon to Buffalo. In the region of heavy soils in the southern part of the county cattle raising is more generally a feature of farming.

To secure an adequate supply of labor is one of the most vexatious problems confronting the farmer. The scarcity of suitable help has made it difficult to carry on farm operations, and this has led some men to resort to share renting. Labor by the month can hardly be secured. In the fruit-harvesting season many laborers are brought in from the villages and cities. Recently Italians, Slavs, and Poles have been employed and in some instances are worked in gangs under a foreman and interpreter, as on construction works. Day laborers receive \$1.50 for ten hours, and by the month from \$25 to \$30, with board and lodging provided.

About 60 per cent of the farms are operated by the owners. Share tenants are about twice as numerous as cash tenants. The usual rent on the share basis is one-half of the products, the owner furnishing part of the seed and fertilizers. The use of fertilizers is increasing. In 1900 about 60 farms were operated by managers.

The average size of farms is 70.1 acres. Of the total area in farms in 1900, 80 per cent was in farms ranging in size from 50 to 175 acres. A larger area was in farms of more than 100 acres in size than of less than 100 acres. Of the 4,356 farms reported, 1,631 contained less than 50 acres and 41 more than 500 acres each. Ninety-one per cent of the area is in farms, and of this 91 per cent, or nearly 83 per cent of the total, is improved.

In 1900 the average value of farm land per acre was \$48. This does not include buildings, which are of an average value of nearly \$22 an acre. The great range in soil and improvements gives a wide range of values. Grain and hay farms are valued less highly than fruit farms. The former will vary from \$40 to \$80 an acre. With the latter the range is much greater and depends upon the extent, variety, and age of the orchards. Bearing apple orchards are gener-

ally the most valuable. Orchard land in good condition is valued at from \$200 to \$300 an acre. Mixed farms on the upland loams and sandy loam soils and bearing moderate-sized orchards are valued at from \$80 to \$125 an acre. Farm buildings have an average value of \$1,524 per farm. Farm machinery of modern type is in general use and finds its greatest employment on fruit farms. The value of implements and machinery per farm in 1900 was \$180, or \$2.90 per acre of improved land. The expenditure for labor and fertilizers per acre of improved land was \$2.20, and the value per farm of products not fed to live stock was \$940.

Considered as a whole the county is one of high agricultural development and compares very favorably with the best sections of the country. Still, much improvement is possible. The most urgent problem associated with the soils is better drainage. A large part of the county is deficient in drainage. This ranges all the way from slow drainage to marshy and swampy land that is flooded a good part of the year. The problem is complicated by the distance to outlets.

There is great need of improving the drainage conditions of all the Clyde soils, some of the Dunkirk soils, and of the Muck areas. The first essential is more large open ditches for outlets. These must be constructed by cooperative arrangement among farmers. The usual procedure is the appointment of a commission in court upon the petition of interested parties. This commission makes the necessary investigations and superintends the construction of the ditch. The cost is assessed against the land benefited. The chief difficulty is that many farmers do not understand the value of drainage and consequently oppose the movement. In this way many propositions in the hands of commissioners are blocked. Better drainage would lengthen the crop season, warm and aerate the soil and enable plants much better to resist drought, would improve the soil tilth and reduce heaving, and make possible the production of crops now grown with indifferent success on many of the heavier soils.

The present system of open drains would be improved by the use of tile drains in all the laterals and many of the smaller mains. These may be readily manufactured from the subsoil of the Dunkirk clay and the Clyde clay. Tile would drain the land much deeper and would greatly facilitate cultural operations and harvesting. On clay soil the objection is that water penetrates to the tile too slowly. This may be obviated by catch basins and sinks made of stone, brush, or other porous material. The above objection does not apply on the loam and sandy loam soils. The open drains should be kept more free of rubbish and vegetation which greatly reduces the flow of water and consequently the capacity of the ditch. Tile should be laid below 2 feet to avoid displacement by the frost.

To all the Dunkirk soils, the Lockport clay, and Tonawanda loam, the addition of organic manures will be beneficial. The heavy soils will be rendered more friable and granular and the sandy soils will be increased in moisture capacity. For this purpose farmyard manures may well be supplemented by catch crops grown for green manuring. Such crops as rye, buckwheat, crimson clover, and even weeds may be used for this purpose. They should be so managed as not to draw too heavily on the moisture needed by the succeeding crop. Animal manures could be made more effective by the use of the spreader, since by this method they would be applied over a large area. In so far as practicable they should be spread as soon as hauled and plowed under at once, unless used as a top dressing for winter crops. In connection with the use of organic manures deeper plowing should be practiced. This will increase the root area and the moisture reservoir. Soil deepening should be gradual, a half inch or an inch per year being sufficient. On the heavier soils those farmers securing the best results generally plow deeper than the average—down to 7, 8, or 9 inches.

On the heavy soils the use of the roller, except where small seed have been planted, should not be practiced. These soils need loosening up and not compacting. Their natural tendency is to become too compact. This is the case with the Dunkirk clay, Clyde clay, Lockport clay, and Dunkirk clay loam. For pulverizing purposes the roller may be supplanted by the planker, disk harrow, and the meeker type of harrow, the last mentioned being the most effective. The bar roller is a much more effective clod crusher than the solid roller.

Definite crop rotations should be more generally practiced. These will vary with the soils and type of farming. They may be shorter and include more cultivated crops on the light than on the heavy soils. On clay soil a long-course rotation should be followed in which plowing is not frequently necessary, but when plowing is done it should be deep and thorough. Perhaps root crops may be introduced advantageously into some of the rotations.

In fruit growing the improvement consists in more fully carrying out the best orchard practices now followed. Spraying must be systematic and thorough, and cultivation, drainage, and pruning are established essentials. There are some orchards which have given good results under sod conditions, but cultivation has more frequently been associated with the successful crops.

While in need of some improvement the agricultural practices for the most part are deserving of commendation. Much credit is due to the Niagara County Farmers' Club for the improved methods now in use and the prevalent prosperous conditions. This is an active organization with a large membership of farmers and fruit growers and is among the first associations of its kind in the State. It holds

monthly meetings at different points in the county and has been the means of bringing about great improvement in agricultural practices, particularly in the line of fruit growing.

SOILS.

The soils of Niagara County have been formed under glacial lake influence. The material from which the soils have been derived ranges in thickness from a few inches where Rough stony land prevails, along the escarpment, to 30 or 40 feet at various points on the plains, but with two exceptions it shows little relation to the consolidated formations upon which it rests.

The basal formations consist of shales, sandstones, and limestone, which have a dip of 25 feet to the mile to the south and have been eroded so that the edges of successively older formations are exposed from south to north. On the Erie plain is the Lower Medina shale of a dark Indian-red color and of a silty to sandy texture. Next above this and exposed along the foot of the escarpment is the Upper Medina sandstone, of fine texture and mottled red or pink and gray color, and red shale. Above this is the Clinton limestone and shale. The steeper part of the escarpment is formed by the outcrop of the Rochester shale—a fine-textured, soft, drab material, above which is the thick-bedded and pure Lockport limestone belonging to the general formation of Niagara limestone. All of the southern part of the Erie plain in the county is capped by the Salina shale.

The advance of the glacial ice swept away all of the residual products, and the present soil materials were formed mainly in the lakes and drainage water that accompanied the northward retreat of the ice margin. The lake materials are generally fine textured, their continuity depending upon the uniformity of the lake conditions. In northern New York the glacial correspondent of lakes Erie and Ontario reached an elevation several hundred feet above their present level and extended many miles to the southward of their present margins. The waters also reached considerably farther south in the great north-south valleys of west-central New York, and in their southern parts attained a higher level than in any other part of the State. The materials deposited in these early lakes are formed in the Genesee, Seneca, Cayuga, and related valleys at elevations considerably above 1,000 feet, and constitute terrace formations of clay and lighter materials with shore lines and deltas of local streams composed of gravelly materials. With the retreat of the ice the lake levels dropped successively and owing to the general northward slope of the country in this region became more extensive until the different bodies of water were united and formed first glacial Lake Warren on the Erie plain and later glacial Lake Iroquois on the On-

tario plain. Many successive levels are recognized by the shore and terrace deposits. One of the most general materials found in these lakes was clay, another consisted of various textures of gravel. A further variation of the conditions was the presence of the melting ice masses containing more or less earthy material that had been picked up in its southward movement. Superglacial streams and ponds sorted and concentrated these materials, and upon the final disappearance of the ice they were deposited in a somewhat promiscuous manner. There is consequently a considerable variation in the present soil conditions.

All these phases of glacial conditions appear to have existed in Niagara County, which was very completely subjected to lake conditions. These, together with the topographic and stratigraphic conditions, give rise to seventeen types of soil. Some were deposited in deep quiet water, while others were formed by swift currents or by wave action, and between the extremes are ranged soils of intermediate fineness. All of the lighter colored sediments are classed in the Dunkirk series and embrace nine types, the Tonawanda loam being a miscellaneous type associated with this series. Where the materials which would have given rise to Dunkirk soils have been subject to marshy or swampy conditions since glaciation and as a result of poor drainage have accumulated considerable amounts of organic matter that imparts a dark or black color, they are classed in the Clyde series. Of these there are three types. Two types, the Lockport clay and Rough stony land, are the result of the near approach of the underlying consolidated formations to the surface. The recent drainage gives rise to three types. The one which has been most perfectly sorted and elevated above continuous overflow is the Huntington loam. Low, wet, variable land constitutes Meadow, and the large accumulations of organic matter form Muck.

The Dunkirk and the Clyde series are distributed throughout the county and are closely related. In general three belts of soil conditions may be distinguished. In the southern third of the county the land is flat with occasional low, rounded ridges and knolls, and in this region heavy clays prevail. The central third, parallel to and including the escarpment, has a predominance of well-drained loam and silt loam with considerable clay loam, sand, and gravelly loam. The surface is undulating to hilly and is the most uneven part of the county. In the northern or lake shore third the Clyde series prevails, with the Clyde loam occupying much the largest area. On the immediate lake shore the lighter Dunkirk soils are most abundant.

The clays of the southern belt were formed under comparatively deep, uniform lake conditions and are heaviest in the eastern part. The heaviest types are the Dunkirk clay and Clyde clay, which differ mainly in the marshy conditions to which the latter has been sub-

jected. Along Tonawanda Creek is the Dunkirk clay loam which seems to overlie the heavier clay formation to the northward. In the town of Pendleton it extends northward to Lockport along the Erie Canal and to the westward becomes more general in distribution. Toward the Niagara River it grades very gradually into the Tonawanda loam, which resembles it in having the same relation of members in the section, but differs in that each corresponding member is a grade or two coarser in texture. The distribution of these clayey types of soil would indicate a more pronounced movement of water along the lines where the loam and clay loam prevail, and probably glacial lake drainage passed Lockport by way of the "Gulf" and along the line of the Niagara River. The latter type was evidently formed toward the close of the lake period and under variable drainage conditions.

Toward the northern part of this belt the Dunkirk loam becomes more abundant, and the material seems to emerge from beneath the clay formation. Well borings sometimes show similar material beneath the clay. Occasionally the loam knolls and ridges scarcely reach the surface, and again they extend to a considerable elevation. Their axes are easterly or northeasterly. Along the escarpment, both above and below, the loam is of general occurrence and is not associated with the heavy clay. East of Lockport it is replaced by a considerable area of Dunkirk silt loam associated with an area of sandy and gravelly material that appears to be the delta of a southward flowing stream, probably of glacial time, that banked the material against the face of the cliffs. The surface soil is sandy, forming the Dunkirk fine sandy loam at that point, underlain by gravel and sand. Judging from the way in which this grades into the silt loam, the latter may have been the result of the same conditions. The variability of the texture of the loam and silt loam types and the frequent presence of good-sized stone indicate highly variable conditions of deposition. They appear to have been laid down coincident with the disappearance of the glacial ice when glacial streams and temporary glacial lakes existed. Probably much of the material was deposited on or against ice masses. The ridged condition of the surface is much less apparent on the Ontario plain than along the escarpment, where the ice retreat would result in a complex border. The Clyde loam, which is most extensive on the Ontario plain and the marshy counterpart of the Dunkirk loam, is a comparatively thin mantle, being generally less than 20 feet in thickness, and is the debris from the ice concentrated and modified by the retreat conditions.

The gravel ridge, of which mention has been made, constitutes the largest area of the Dunkirk gravelly sandy loam. It was presum-

ably an offshore bar in glacial Lake Iroquois, on the lakeward side of which considerable areas of sandy material were deposited. These are most abundant in the eastern half of the county. At the foot of the bar is the light beach sand, forming the Dunkirk fine sand, which grades outward into the larger and lower lying areas of Clyde fine sandy loam, the largest body of which occurs in Hartland and Newfane towns. Associated with this last-named type, though higher lying and better drained, is the Dunkirk fine sandy loam.

Farther north on the Ontario plain occur a number of irregular areas of Dunkirk gravelly sandy loam and Dunkirk fine sandy loam, the largest areas of the latter lying near the lake shore in the town of Somerset. The Dunkirk loam is the dominant soil near the lake shore, and there are also two considerable areas of Dunkirk silt loam. Between the ridge and the escarpment the prevailing type is the Dunkirk clay loam.

The broken, noncultivable land along the escarpment and Niagara River, composed mainly of rock outcrops, with a thin uneven covering of fine earth, constitutes the Rough stony land. At a number of points on the Ontario plain the underlying red shale approaches very near the surface where it has decayed and become mixed with glacial materials to form the Lockport clay. The most important areas are just north of Lockport, and in Somerset, Hartland, and Lewiston towns. These were probably elevations when the ice advanced and served to hinder the underflow of the ice so that a great many boulders, often of large size, were stranded. Much of the surface of this type is now strewn with these boulders, most of which are crystalline in character.

At several points in the county are small, irregular, barren areas of soil bearing an alkali incrustation in dry weather. One of these is associated with the Lockport clay just north of Lockport, and another occurs a couple of miles east of Ransomville. Samples from the former area which were analyzed show 1.2 per cent of soluble salt in the surface 6 inches, nearly all of which is common salt or sodium chloride (NaCl). A very little sulphate is present. These areas are generally termed "salt licks," as they were visited in early times by deer and other animals.

Along the Erie Canal on the Erie plain between the escarpment and its junction with Tonawanda Creek are broad embankments of earth which were thrown up in excavating the channel. The greater part of this is a silty material elevated from 20 to 30 feet above the general level of the country and having good drainage. This silt has been derived from the deeper excavations and resembles the Dunkirk silt loam in texture. In a region of clay soil this material is marked out by the lines of thrifty orchards it bears, many of the

trees being of advanced age. The thrifty growth of all crops indicates that such excavated material may become highly productive.

Along the streams a limited amount of alluvial material has been accumulated to form the Huntington loam and Meadow. These types are of small extent. In several undrained depressions organic remains have accumulated to a considerable depth, forming Muck. Along the ridge these are ice-block holes; in other places they are natural depressions from other causes.

With this outline of the general soil conditions the different types may be taken up and described in detail. The name and extent of each type are given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Dunkirk loam.....	82,496	23.6	Dunkirk gravelly sandy loam.....	6,400	1.8
Dunkirk clay loam.....	56,960	16.3	Huntington loam.....	5,248	1.5
Clyde loam.....	55,360	15.8	Muck.....	4,608	1.3
Dunkirk clay.....	37,440	10.7	Dunkirk sandy loam.....	4,480	1.3
Clyde clay.....	18,752	5.4	Dunkirk fine sand.....	3,520	1.0
Dunkirk fine sandy loam.....	17,728	5.1	Rough stony land.....	3,392	1.0
Clyde fine sandy loam.....	15,488	4.4	Meadow.....	1,216	.3
Tonawanda loam.....	15,168	4.3	Total.....	349,962	.....
Dunkirk silt loam.....	15,040	4.3			
Lockport clay.....	6,656	1.9			

DUNKIRK CLAY.

The soil of the Dunkirk clay consists of a clay loam or clay from 5 to 8 inches deep, varying from light to dark brown in color. The subsoil is usually a stiff, heavy, waxy clay of variable color, which differs in different parts of the area. Near the Niagara escarpment it is a dark brown, frequently tinged with red or pink. In other parts of the area where the drainage is not as good it is usually lighter, being blue, drab, or gray, and is frequently mottled with iron stains. Owing to its fine texture care must be taken in working this soil. If plowed before it is sufficiently dried out in spring it clods easily and considerable difficulty is experienced in getting the soil sufficiently pulverized to form a seed bed.

The greater proportion of the Dunkirk clay occurs as large areas in a belt across the county 1 to 2 miles south of the Niagara escarpment and extending south to within 2 miles of Tonawanda Creek. A few small areas are found on the lower table-land north of the escarpment.

The surface features of this type vary from gently rolling to flat. It reaches its greatest elevation near the escarpment, where slight variations in the surface are noticeable, whence it slopes gently to the southward. As it approaches Tonawanda Creek there is less and

less irregularity in the surface until in the southern part it becomes quite flat.

The general level character of this type, together with its low-lying position and heavy texture, makes it a poorly drained soil. Artificial drainage by means of open ditches is resorted to to carry off the surface water, the same system being employed as on the Dunkirk clay loam.

The Dunkirk clay is lacustrine in origin, consisting of uniform, fine particles derived from reworked glacial material deposited in quiet water near the close of the glacial period.

Grain and hay are the principal crops grown on this soil. On the higher portion of the type beans are grown to some extent, yielding from 10 to 18 bushels per acre. Corn yields from 20 to 50 bushels, oats 40 to 60 bushels, wheat 15 to 35 bushels, and hay from 1½ to 2½ tons per acre, the yields usually being slightly higher than on the Dunkirk clay loam. The usual rotation is sod, fall plowed when practicable, oats, wheat, and hay from two to four years. Very little corn, potatoes, and beans are grown, and when produced are placed in the rotation after sod. Hay and wheat are the leading crops, the hay consisting of timothy and either red or alsike clover, which will continue to give a profitable crop for several years. Manure is applied to the sod. Commercial fertilizers are sometimes used on wheat. Complete mixtures of about 2-8-2 proportion have given fair results.

The drainage of all this type is deficient, and much of it is also deficient in organic matter. It is usually plowed too shallow, and is consequently dense and poorly aerated. As a result of these conditions the average yield is much below what it might be. The greatest improvement will result from thorough drainage, which in addition to removing excess of water will afford better aeration. The application of as much organic matter as practicable, a wise rotation, and plowing occasionally to a depth of 7 or 8 inches will lighten this soil and render it drier and much easier to cultivate. It is valued from \$40 to \$75 an acre.

The following table gives the average results of mechanical analyses of this soil:

Mechanical analyses of Dunkirk clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
16110, 16112.....	Soil	0.5	1.8	1.4	3.4	2.4	50.4	40.0
16111, 16113.....	Subsoil.....	.1	.8	.7	1.7	1.4	43.3	52.8

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO₃): No. 16111, 11.10 per cent; No. 16113, 1.91 per cent.

CLYDE CLAY.

The soil of the Clyde clay consists of a heavy dark-brown or black clay loam 4 to 8 inches deep. It contains a relatively high percentage of organic matter, which gives it a somewhat more loamy character than it would otherwise have. When dry, deep cracks are formed which extend down into the subsoil for 2 or 3 feet, while the surface soil cracks into small cubical blocks from one-sixteenth to one-fourth inch in diameter. During the freezing weather of winter the soil heaves badly, causing considerable injury to the roots of growing wheat and grass. The subsoil to a depth of 36 inches or more is a heavy waxy clay. It varies in color from a blue-black to dark-gray or drab, and in some cases is a bluish-brown. The generally heavy character of this type makes cultivation extremely difficult.

The Clyde clay is found principally in the southern half of the county closely associated with the Dunkirk clay loam and Dunkirk clay. A few scattered areas are found in the northern part of the county, the one just north of Model City being quite extensive and typical.

The type occupies depressions, usually in the clay formations. These are generally shallow and flat bottomed or saucer shaped. As a result of its position natural drainage is very poor. Much of it is flooded in spring, and some of it remains in a semiswampy condition and is still covered with timber. The native timber was elm of excellent size and quality, with a sprinkling of other wet-land species, such as black ash, alder, tamarack, etc. The large area near Model City is better drained than the majority of the type. Here, as on other types in the county, artificial drainage by means of open ditches is resorted to.

The same rotation of crops and methods of culture are practiced on the Clyde clay as on the Dunkirk clay loam and Dunkirk clay with the exception that corn more frequently finds a place. Owing to the lateness of its drying out in spring it is usually fall plowed for oats. Yields are slightly less than on the types just mentioned, except in comparatively dry seasons, when they are much larger. Wheat yields from 15 to 25 bushels per acre, oats 30 to 50 bushels, and corn 25 to 50 bushels. It proves a very good hay soil, yielding from 1½ to 2½ tons per acre. Yields as high as 40 bushels of wheat, 70 bushels of oats, and 75 bushels of corn have been obtained. The chief reason for smaller yields is the poor natural drainage, which necessitates late planting and promotes severe winter and spring heaving as well as summer injury from flooding. In the north-central States the Clyde clay has proved a very good sugar-beet soil. North of Model City, where the drainage is much better than at other points, pears and plums are grown quite successfully on the Clyde clay. Present values of the type range from \$45 to \$65 an acre.

The results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Clyde clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent</i>	<i>Per cent.</i>				
16137.....	Soil	0.1	1.5	2.1	4.8	3.7	46.2	41.4
16138.....	Subsoil.....	.0	.3	.4	1.2	3.5	48.0	45.7

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16138, 10 per cent.

DUNKIRK CLAY LOAM.

The Dunkirk clay loam varies from a dark-brown to grayish clay loam 8 to 10 inches deep, beneath which is a heavy clay loam usually grading within a few inches into a stiff, impervious clay. The upper part of the subsoil is usually brown, tinged with red, but with increase of depth it becomes a dull brown, sometimes mottled with drab or yellow. Along Tonawanda Creek and its tributaries the subsoil is somewhat different from the typical material both in texture and color. At first it is a light-drab or gray material having the same texture as in other sections, between 15 and 30 inches it is usually a light-brown mottled clay loam, and below 30 inches it becomes much lighter in texture, frequently being a fine sandy loam light-brown or pinkish in color.

The larger part of the Dunkirk clay loam is found on the upper table-land south of the Niagara escarpment. Through this region large irregular areas are found scattered the entire length of the county from east to west, while along Tonawanda Creek it forms an almost continuous area 1 to 2 miles in width. Northeast of Pendleton it is much more sandy than the average, the sand reaching the surface in irregular lenticular areas. The surface is somewhat hummocky and the soil varies in color from gray to brown. Several quite extensive areas occur between the Ridge road and the foot of the escarpment. Those along East branch, just east of Wrights Corners, are very silty and along the bank resemble the Dunkirk silt loam, but because of drainage and position are classed with the clay loam, though a considerable part is quite rich in organic matter. Smaller areas are found in several places on the lower plateau north of the escarpment, a few of them occurring on the shore of Lake Ontario.

The surface of this type varies from gently undulating to level. In the southern part of the county it has very little or no surface slope and drainage is very much retarded. Owing to the comparatively level topography and the heavy structure, surface water is

carried off very slowly, and artificial drainage is resorted to over the entire type. This is usually accomplished by a series of parallel ditches which are open after the soil has been fitted for a crop. These are fairly efficient, but take up considerable space and are inconvenient to work over with binders and other farm implements. Tile drains would prove more effective and would be found to be cheaper in the end than the open drains.

The Dunkirk clay loam is of lacustrine origin from glacial material. The greater part of this soil was laid down during a period of uniform quiet water which admitted of the deposition of the finer sediments. The sandy layer at the base of the subsoil in the vicinity of Tonawanda Creek indicates a period when the water was in motion, followed by a period of quiet which admitted of the deposition of finer material upon the sand which had been previously laid down.

In its native state this type was covered with hardwood forest, but most of this was removed years ago and the type is nearly all under cultivation.

Position and drainage conditions make the Dunkirk clay loam best adapted to grains and grasses, a fact which is quite generally recognized by the farmers. Wheat, oats, corn, and hay are the principal crops. Wheat yields from 15 to 30 bushels, oats 30 to 50 bushels, corn 25 to 50 bushels, and hay about $1\frac{1}{2}$ tons per acre. West of Lockport, along the escarpment, it is considered a good grape soil. Near Lake Ontario, where it has the best natural drainage of any point in the county, some large apple orchards are found, but the main body of the type lies too low to be of any value as a fruit soil.

A common rotation on this soil consists of plowing sod land and planting it to corn. The next season a coating of barnyard manure is applied and the field sown to oats. After the removal of this crop the ground is fitted for wheat. At the time the wheat is sown it is usually seeded to clover and timothy. After the removal of the wheat it is left in grass for hay and pasture for two to four years. Commercial fertilizer is sometimes applied to oats and wheat, but this practice is not general.

The drainage of nearly all of this type needs to be improved and much of it, particularly the light-colored phase along Tonawanda Creek, needs more organic matter. This type is better adapted to corn than is the Dunkirk clay.

As compared with other soils of the area, the Dunkirk clay loam has about an average value. At the present time (1906) it can be bought for \$45 to \$75 an acre.

The table on page 33 gives the average results of mechanical analyses of this soil.

Mechanical analyses of Dunkirk clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
16106, 16108.....	Soil	0.5	2.5	1.9	5.4	5.4	57.6	26.2
16107, 16109.....	Subsoil.....	.2	1.8	1.2	4.2	3.9	48.3	40.8

TONAWANDA LOAM.

The surface soil of the Tonawanda loam consists of a brown to black fine mellow loam, varying in different localities from 8 to 16 inches in depth, with an average depth of 12 inches. The subsoil consists of a drab or yellow and brown mottled clay loam or loam to a depth of 24 to 30 inches. This heavy material in turn is underlain by a light-yellow loam or sticky sandy or silty loam to a depth of 3 feet or more. This material closely resembles brown sugar, both in color and in texture. Frequently the last few inches of the section is a sticky sand. While the heavy subsoil varies considerably in depth, it always gives way to the lighter material, which peculiar characteristic enables one easily to recognize this type. It is also this feature which distinguishes the Tonawanda loam from the Clyde loam and the low-lying phase of the Dunkirk clay loam. The soil is composed of the finer grades of sand and of silt, and in some localities resembles a silt loam. Both soil and subsoil are devoid of coarse material.

The Tonawanda loam occurs only in the southwestern part of the county, where it forms a continuous body about 11 miles long bordering Tonawanda Creek and Niagara River. It terminates about 2 miles east of Niagara Falls. The surface is low and flat, with only slight elevations along small stream courses and along the Niagara River. These slight undulations are better drained and represent the lighter phase of the type, both soil and subsoil being somewhat lighter in texture. For the most part the natural drainage of the type is deficient; during heavy rains portions of it are submerged for weeks at a time. No tile drains were found on this type, and the large open ditches which have been constructed have not sufficient fall to carry off the surface water during wet periods.

The Tonawanda loam is alluvial in origin, the material composing it having been laid down upon the lacustrine clay deposit. At North Tonawanda the alluvium is 15 feet deep and rests on the heavy, stiff clay foundation. North from this point the loamy material gradually becomes more shallow and finally disappears, giving place to the heavy types derived from underlying clay. The surface soil of the Tonawanda loam has been more or less reworked and has incorporated within it a high percentage of organic matter.

The chief crops grown upon this type are corn, oats, hay, and potatoes. During favorable seasons fair yields are produced, but crops are practically ruined on an average of one year out of three. On the higher lying portion crops are more certain, and apples and pears give fairly good yields. It is not, however, well adapted to fruit. Along the Niagara River front a considerable part of the type is devoted to market gardening.

The average results of mechanical analyses of samples of this soil are shown in the following table:

Mechanical analyses of Tonawanda loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
16126, 16129..	Soil.....	0.3	0.4	0.3	4.4	27.1	48.3	18.6
16127, 16130..	Subsoil.....	.0	.1	.2	4.2	34.6	41.2	19.1
16128, 16131..	Lower subsoil..	.2	.6	.5	11.9	42.6	36.9	7.2

DUNKIRK LOAM.

The soil of the Dunkirk loam consists of a dark to light-brown rather silty loam from 7 to 12 inches in depth. Silt and sand are present in varying amounts, forming on the average a mellow easily cultivated soil. The subsoil is variable in texture, and is made up of lenticular strata of clay or clay loam, silt, and sandy material, giving it the average texture of a loam. The relation of these is not uniform, but it is usual to find under the soil a heavy stratum of clay loam which gives way to silty or sandy material, and this in the bottom of the 3-foot section to another band of heavy material.

Borings near each other are frequently quite different in the order and thickness of the materials. This is apparent from the lenticular structure and cross bedding. Even thin strata of coarse sand and gravel may sometimes be encountered, but these are not common. Sometimes the clayey band may form the surface and give way to the lighter materials in the upper subsoil. The characteristic of the section is great variability in texture from point to point, but no single class of material is very extensive either in areal distribution or thickness. The sandy loam, clay, or silt strata may occur at any horizon in the section and in any order.

In addition there is generally present a considerable amount of gravel and stone consisting of a predominance of sandstone and shale, with many of igneous origin and great variety. These are generally rough and subangular rather than smooth and rounded by water action. The amount of stone is not constant, and on a few areas is so abundant as to hinder cultural operations.

In color the subsoil is also variable, but is generally of a brownish cast. The different strata of material may differ in color. The sandy strata are inclined to gray, while the heavier materials are some shade of brown or pink. The pink or red color of the material is most common along the escarpment and to the south of it. This is probably due to material derived from the red Medina shale and sandstone of the lower plain which has been transported by glacial action.

Although found in every section of the county, the largest areas of Dunkirk loam are distributed along the escarpment on its crest and northern face and along the lake shore. The body around Middleport is most uniform and typical, except along the county line, where it is inclined to be rather heavy. Along the foot of the escarpment it is rather stony, and just north of Lockport it is exceedingly stony, the rock consisting chiefly of Medina sandstone, which appears in the soil in many small fragments, their partial decay having imparted a more than average sandy character. Here the clayey bands are generally absent, so that this phase is slightly lighter than the average. It is, however, not less productive and bears some of the finest orchards in the county. Some parts of the large area in northern Somerset Township are exceedingly stony, also, and these are best utilized in fruit culture. In the southern part of the county the type occurs in rather small areas, usually as isolated, low, rounded ridges and knolls protruding through the lacustrine clay deposits. Sometimes they scarcely reach the surface, and again they may attain an elevation of 20 to 40 feet above the general level.

Topographically the Dunkirk loam is the most undulating and hilly type in the county, with the exception of the Rough stony land and some parts of the Dunkirk silt loam. As has been mentioned, south of the escarpment it is characterized by ridges and knolls, which fact has much influenced the distribution of roads and location of farmhouses. These are invariably on the eminences of the Dunkirk loam both because of the better drainage and its better adaptation to garden crops. Along the escarpment it slopes northward, having been piled against the face of the outcrop to a considerable depth.

The northern areas have a more level surface, but are sufficiently elevated to avoid the poor drainage that distinguishes the Clyde soils with which it is generally associated. Scarcely any of the type is uncultivated because of surface slope.

While the drainage is in general fairly good, it is not perfect, and many areas would be benefited by the use of tile. The inconvenient surface ditches are certainly not excusable on this type, as both its

position and texture favor the successful operation of tile. These were found in use in several places with good results.

The soil has been formed by a very complex set of conditions, which are responsible for its great variability in section. It was presumably formed on the margin of the retreating ice, and probably much of it was deposited in ponds and streams on the ice or banked against ice masses. Only such conditions could give the change and variety in texture and add the large stones that are frequently present in the body of fine material. The strata of clay represent the quiet sedimentation conditions of a temporary pond or lake. The coarse sediments—sand and gravel—represent the stream deposits, while the silts represent conditions of very slow general movement. The stones were dumped with the melting of ice blocks.

The result is a soil of high natural productivity and good cultural qualities. Originally it was covered by a heavy growth of hardwood trees, prominent among which were hard maple, elm, basswood, tulip poplar, black walnut, and some oak, chestnut, beech, and hickory. The ancient Indian term for this region was the "Basswood country," from the prevalence and sturdy growth of this species. The tree growth was considered indicative of the productive capacity of the soil, and the correctness of this opinion has been confirmed and demonstrated in practice.

The Dunkirk loam is the best general-purpose soil in the region. It gives good yields of all grain and hay crops and is especially well adapted to fruits of all kinds suited to the climate. Corn will yield from 40 to 100 bushels, wheat 15 to 30 bushels, oats 40 to 60 bushels, beans 15 to 30 bushels, potatoes 90 to 150 bushels, and hay $1\frac{1}{2}$ to 2 tons per acre. These great variations in yields result from the cropping system, cultural methods, seasonal conditions, and slight variations in the soil. Average yields—always difficult to state—would be nearer the lower than the upper limits mentioned.

A very definite rotation as to courses is followed on this type. Sod land is planted to one of the cultivated crops, corn, beans, or potatoes, and these are followed by oats and wheat, the latter seeded to timothy and clover, which stands for from two to three years. Manure is applied to the sod and oat stubble. Fertilizers when used are applied to the oats and wheat, chiefly the latter, also to beans and potatoes. This is the leading bean soil in the county.

Besides general crops, a very large acreage of the type is devoted to fruit production. Throughout the county it is distinguished by the prevalence of apple orchards. In the southern part the small area may almost universally be recognized by the presence and condition of the orchard. The trees have made a good growth and are regular in form and thrifty in appearance. While other types may

produce good apples the opinion of a large number of apple buyers and packers is that apples grown on this soil are of superior flavor, color, and keeping quality. It was found that they report the best market apples from the sections where this type prevails. While the peach thrives on a soil much lighter than is suitable for the apple, it is said by a number of practical men that on this soil is obtained fruit superior in flavor, color, and keeping quality.

Pears, plums, and quinces are also successfully produced, and some of the best orchards of these fruits in the county are on this type. Cherries are grown, and west of Lockport there is a large acreage of grapes. The Niagara grape was originated on the stony phase of this type in the northeastern part of the city of Lockport. Small fruits thrive, and canning and truck crops are produced in considerable quantities. The soil responds well to careful management and good treatment.

Taken as a whole, it is probably valued higher than any other type. Owing to the fact that a farm is seldom composed of this type alone it is not easy to arrive at a valuation. The price is influenced by the location with reference to roads, towns, and markets. It is also dependent upon the extent and age of the orchards. A number of farms devoted to mixed crops are held at \$125 an acre, while orchard areas are worth much more. Some areas may be purchased at considerably less than \$100 an acre.

The following table gives the average results of mechanical analyses of fine-earth samples of this type of soil.

Mechanical analyses of Dunkirk loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
16084, 16086	Soil	0.9	4.2	3.3	6.4	13.5	52.9	18.4
16085, 16087	Subsoil.....	.0	1.7	1.4	5.5	4.3	54.9	32.1

DUNKIRK SILT LOAM.

The surface soil of the Dunkirk silt loam consists of a light-brown to yellow silt loam from 8 to 12 inches deep. The soil is usually free from stone and gravel and contains a considerable percentage of very fine sand. In some places it is a fine sandy loam. The subsoil is a brown, yellow, or pink silty or fine sandy loam usually grading into a heavy silty loam.

Three good-sized areas of the Dunkirk silt loam were mapped, besides numerous smaller areas scattered throughout the county. The largest body occurs east of Lockport, where the silt is found intimately associated with the underlying sand. Much of this soil is

found containing a varying proportion of very fine sand. The area north of Appleton, bordering Lake Ontario, is more typical of the Dunkirk silt loam as mapped in Niagara County. Near the lake bluff, however, the typical silt loam soil is underlain by a heavy brown silty clay. The other area of important size borders the lake east of Youngstown.

The type as a whole occupies gently rolling country and most all of it is naturally well drained. The small areas bordering Tonawanda Creek are an exception, these being low, flat, and sometimes poorly drained. They are subject to overflow and are closely related to the Huntington loam. In their origin, mode of occurrence, level topography, and naturally deficient drainage, they are practically identical.

The Dunkirk silt loam is sedimentary in origin and consists of the finer grades of glacial material reworked and deposited by lakes and streams. The conditions under which it was formed were similar to those forming the Dunkirk loam.

The original forest was of a larger growth of softwood trees than that on the Dunkirk loam. The area east of Lockport is called "Chestnut ridge" from the prevalence of that species. Soft maple and elm were common and the other species mentioned for the Dunkirk loam were represented.

The high-lying phase is a mellow, easily tilled, and early soil. It is admirably adapted to truck and fruit, and produces good yields of all the general farm crops of the county. Oats average 50 bushels per acre, corn 60 bushels, and hay 1 to 2 tons. It compares favorably with the other fruit soils within the modifying influence of the lake, and a large acreage is planted to peaches, apples, plums, pears, and grapes. It supports a thrifty, well-developed tree and produces a well-flavored fruit. Trees make a larger and more rapid growth than on the Dunkirk loam. For apple production it stands next to the Dunkirk loam, and for peaches it is as good or perhaps better. For cherries it is a better soil than the loam, while for pears, plums, and quinces it is a good soil, though not the best. It is much prized as a nursery stock soil because of the strong growth obtained and the ease with which the roots may be removed without injury. A number of large nurseries are located on the type, and for market garden crops it is as good a soil as found in the county. Potatoes of good yield and quality are produced. The areas in the southern part of the county along Tonawanda Creek are not so well adapted to fruit, but produce profitable yields of farm crops, truck, and canning crops.

The areas east and north of Lockport are valued at from \$100 to \$125 an acre. The other areas vary in value on each side of these figures.

The average results of mechanical analyses of samples of the Dunkirk silt loam are shown in the following table:

Mechanical analyses of Dunkirk silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
16100, 16104.....	Soil	1.1	2.0	1.0	4.9	15.2	66.3	9.1
16101, 16105.....	Subsoil.....	.6	1.4	.9	3.7	13.2	62.2	17.3

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16105, 2.36 per cent.

LOCKPORT CLAY.

The Lockport clay is a heavy red to brown clay loam from 4 to 8 inches deep, underlain by a stiff Indian-red clay. The red Medina shale sometimes occurs within 3 feet of the surface. The Lockport clay is confined to the lower table-land, or Ontario plain. Underlying that portion of the county north of the Niagara escarpment is the Medina shale, which is covered with glacial material of varying depths. Where the shale is comparatively near the surface it has given rise to the Lockport clay. The soil, therefore, is largely residual, being the weathered product of the red shaly rock mixed with some glacial material near the surface. Under most of the type the bed rock occurs at a depth greater than 3 feet, but occasionally it is encountered within the third foot. The surface soil has undergone but little change, still possessing the characteristic red color of the parent rock. In depressions where organic matter has been incorporated with the soil it takes on a rusty-brown color.

This type of soil does not occupy extensive areas and topography offers no index as to where it is to be found. The largest body is situated north of Lockport. Other good-sized bodies occur northeast of Johnson Creek, in the vicinity of Barker and Model City and north of Dickersonville. Small areas are confined mostly to the northeastern part of the county.

The Lockport clay is marked by nearly level areas, the surface of which is thickly strewn with large granitic boulders. Owing to its level, stony nature the greater part of the type is devoted to pasture and wood lots. It is best suited to grass, which fact has been generally recognized. Some corn and wheat are grown, but the yields are only moderate. There is often an uneven crop growth, which is perhaps due to the close proximity of the underlying shale.

The type is difficult to cultivate and is not considered a productive soil. The crop returns do not justify clearing and the removal of the numerous boulders, hence the greater part of the type is left in

its native state. The timber consists of an undersized growth of oak, hickory, and poplar. Tree fruits of all kinds are generally a failure on this type. Bush fruits succeed better, and on the area north of Lockport a considerable vineyard has been established and has made a fair growth. The chief difficulty for deep-rooted plants is the near approach to the surface of the dense shale formation. This can not be overcome by cultural methods, and it is best met by the adoption of crops that can thrive in such an environment.

The following table gives the average results of mechanical analyses of this soil:

Mechanical analyses of Lockport clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
16120, 16122.....	Soil	0.7	2.2	1.9	3.3	4.0	53.0	34.6
16121, 16123.....	Subsoil.....	.2	2.0	1.5	3.5	6.6	48.1	37.8

ROUGH STONY LAND.

The Rough stony land of Niagara County is represented by the outcropping of the Medina sandstone and the Clinton and Lockport limestones. The former occurs in the vicinity of Lockport and gives rise to a thin, irregular soil covering, varying from a silty to a fine sandy loam and from a few inches to 2 feet in depth. An abundance of the deeply decomposed sandstone is present in the soil, and bed rock is frequently exposed upon the surface. The weathering of the limestone formations has produced a dark-colored loam. Where influenced by the Rochester shale, the loam soil is light colored.

Rough stony land occurs around "The Gulf" at Lockport and at intervals as a narrow ridge on the crest of the Niagara escarpment. From Dickersonville it extends as a continuous narrow strip to Lewiston, from which point it follows "The Gorge" south to the Niagara Falls. From Lewiston to the falls the type occupies a precipitous position and much bare rock is exposed.

Upon the more level portion of the area at Lockport some cultivation is practiced, but the varying depth of the soil produces an uneven crop growth. The deeper soil produces good yields of corn, oats, and fruit. Raspberries and strawberries do well and are of excellent quality. The rest of the type is nonagricultural, but supports some grass and timber.

DUNKIRK GRAVELLY SANDY LOAM.

The surface soil of the Dunkirk gravelly sandy loam is a dark or light-brown gravelly sandy loam from 10 to 15 inches deep. The soil contains a high percentage of small waterworn pebbles about the size

of a pea. The subsoil is a light-brown or reddish-brown medium to coarse sand or sandy loam containing a considerable quantity of small gravel. The deep subsoil consists of stratified gravel and sand. Besides the small gravel, some parts of the type contain from 30 to 60 per cent of large cobblestones.

The Dunkirk gravelly sandy loam is typically developed in the ridge upon which is located the Ridge road. This formation represents an old beach line, consisting of reworked glacial material varying greatly in texture. Besides the ridge area the type is also found as detached ridges and isolated knolls in the northeastern part of the county. It occurs only in this section and does not appear south of the Niagara escarpment. The detached areas are not typical, but consist of at least 50 per cent of cobblestone, while the finer grades of gravel are lacking in both soil and subsoil. The ridge, however, is very stony in some parts, especially northeast of Wrights Corners. From Hartland Corners eastward it is very light and sandy, except a narrow strip on the north slope at the side of the road.

The type is well drained, and its texture makes it an early soil, well suited to market-garden crops and fruit. The ridge is devoted almost exclusively to truck and fruit, which do exceedingly well, except in seasons when the rainfall is below the average. Cherries do exceptionally well. The whole ridge is thickly planted to peaches, apples, plums, pears, and grapes, most of which are grown with profit. The greater part of the market-garden crops supplied to Lockport is grown upon this soil. Several greenhouses furnish both the local and Buffalo trade with their product. The areas to the north of the ridge are almost all planted to fruit and on account of their exceedingly stony nature are not cultivated to general crops. The stony phase produces better crops and fruit than the sandy phase, which is much subject to drought. On the sandy phase, trees, particularly apples, make a slow growth, while on the other phase they are as thrifty as on other types. For cherries, this type of soil is one of the most successful, and on the ridge this fruit is planted along the road almost continuously. It also produces some of the best melons, especially cantaloupes, grown in the county. The deep gravelly subsoil of the ridge formation affords an excellent road-facing material.

The following table gives the average results of mechanical analyses of the fine earth of this type of soil:

Mechanical analyses of Dunkirk gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
16090, 16092.....	Soil	8.1	15.5	11.5	18.4	8.3	30.7	7.2
16091, 16093.....	Subsoil.....	7.8	16.7	9.8	23.3	8.2	28.2	15.9

DUNKIRK FINE SANDY LOAM.

The Dunkirk fine sandy loam consists of a light-brown to yellow fine sandy loam from 10 to 15 inches deep, underlain by a yellowish fine sandy loam or fine sand. The soil is a loose, mellow, friable loamy material composed of the finer grades of sand and silt. The subsoil is often incoherent fine sand, which usually grades into a reddish-brown or pinkish silty material at 30 inches. Thin layers of this material and clay nodules of the same color are frequently encountered at a lesser depth. Small iron concretions are often present in both soil and subsoil, and when decomposed often give the subsoil a streaked appearance.

The Dunkirk fine sandy loam is not found south of the Niagara escarpment, but bodies of varying size are scattered throughout that portion of the county lying north of it. The type occurs as broad, irregular, hummocky areas, as long, low, narrow ridges, and as isolated knolls. It is very gently undulating in topography, naturally well drained on account of its position and favorable texture, and comparatively free from local variations. The area east of Lockport is the most uneven. The type is much better drained than the Clyde fine sandy loam and its color, due to position and drainage, forms the basis for its separation from the dark sandy material. The texture of both soil and subsoil of these two fine sandy loam types is similar. In the case of the Dunkirk fine sandy loam, the glacial sands occupying a higher topographic position have not been submerged for so long a period and have not undergone the same amount of reworking. Some parts of the type have undoubtedly been influenced by wind action, and it is a noticeable fact that the majority of the areas in the northeastern part of the county have a trend parallel to the present shore of Lake Ontario.

For general farming the Dunkirk fine sandy loam is a little too light, although fair yields are secured. Hay will yield from 1 ton to 2 tons per acre, and a large acreage is grown each year. Wheat will yield 10 to 18 bushels, oats 30 to 40 bushels, and corn 50 to 75 bushels per acre. It is a typical truck soil and well adapted to early garden crops. Many truck crops are successfully grown. The demand for such exceeds the supply, owing to the increased number of canning and preserving factories located within the area. The Dunkirk fine sandy loam is a satisfactory peach soil, producing a strong, thrifty tree and a good-flavored fruit. Apples, pears, and plums do only fairly well. Grapes are successfully grown. In general, peaches and apples thrive better than other tree fruits, but as a rule the flavor and keeping quality are not as good as in the fruit produced on the Dunkirk loam or the Dunkirk silt loam. Successful orcharding on this type depends more on the depth of the formation than on the texture of the surface material. There are occasional areas of deep

sand or sandy loam where the trees do not thrive so well. These are variations probably due to wind action. The most successful orchards are on the borders of the sandy areas. In addition to tree fruits small fruits are very satisfactorily grown on this type. Of these strawberries, raspberries, blackberries, currants, and gooseberries may be mentioned. For these it is probably the best type in the county. Potatoes of very good quality are also grown and fair yields are secured. By proper management, which includes the generous use of organic manures and commercial fertilizers, very high yields may be secured. Buckwheat is frequently grown as a catch crop.

The average results of mechanical analyses of fine-earth samples of this type of soil are given in the following table:

Mechanical analyses of Dunkirk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
16096, 16098.....	Soil	0.2	1.8	2.4	27.0	41.6	15.8	10.8
16097, 16099.....	Subsoil.....	.4	2.2	1.4	23.8	49.4	15.6	6.4

DUNKIRK FINE SAND.

The surface soil of the Dunkirk fine sand is a medium to fine light-brown or gray loamy sand 4 to 6 inches deep. The subsoil is a yellow to brown loose, incoherent sand resembling the soil in texture.

In extent the Dunkirk fine sand is limited and in agricultural value is of little importance. It occurs mainly in the northeastern part of the county where the largest areas are found bordering the Ridge on the north and south. These areas are closely associated with the Dunkirk gravelly sandy loam and occur in the form of long, narrow strips, which broaden to nearly a mile in width at the western end. Fine waterworn gravel is present in both the soil and subsoil of these areas. Other isolated areas occur as ridges and knolls, the largest of which is located 2 miles west of North Hartland. The soil here is practically free from stones and gravel.

The type is nearly all well drained, the exception being east of Ridgeroad post-office, where drainage is not uniform. Here the soil is dark and more loamy.

The Dunkirk fine sand closely resembles the Dunkirk fine sandy loam. The smaller bodies of sand are nearly always found within the fine sandy loam type. In origin they are practically the same, being derived from lake deposits either in the form of old beach lines or wind-blown ridges and knolls.

This type is the lightest soil of the county. Melons, tomatoes, cucumbers, and small fruits are grown successfully. Liberal applications of fertilizer are necessary to secure the best results and to

maintain its productiveness. Peaches, apples, and pears are grown, but the trees are usually short lived and subject to disease, and the fruit is of an inferior quality. The type is not suited to general farming, but for truck and other crops requiring a light sandy soil it will prove valuable. The application of farmyard and green manures is particularly important. The soil needs to be compacted as much as possible, and in addition to the use of organic manures care should be taken to maintain sufficient moisture to aid the processes of decay.

DUNKIRK SANDY LOAM.

The Dunkirk sandy loam is composed of the coarser grades of the same material which gives rise to the Dunkirk fine sandy loam. The soil to a depth of 12 to 15 inches is a brown, coarse to medium textured, sandy loam, frequently containing fine gravel. The subsoil is a light-brown sandy loam of a coarser texture than the soil. There is often present fine gravel in varying amounts. In some areas the soil is composed of medium sand and fine gravel embodied in a matrix of fine sand and silt.

The principal areas of Dunkirk sandy loam are found in the vicinity of Olcott and Coomer Station. Smaller areas occur at other points on the Ontario plain. The topography is gently rolling, and the soil with its porous and friable texture is thoroughly drained.

It is derived from glacial sands which have been reworked and deposited under moving water. There is no evidence of wind action as in the case of the finer sands of the area.

As most of the type is located within the zone whose climate is modified by Lake Ontario, it is devoted chiefly to the growing of fruit. It is a desirable soil for peaches and to a less degree for apples, pears, and plums. It produces a strong healthy tree and a well-flavored salable fruit. Several fine orchards are located on this soil, and its adaptation to fruit is generally recognized. Trucking is also carried on to a limited extent. Cabbage, tomatoes, melons, cucumbers, and potatoes are grown, but general farming is not practiced. The production of such flowers as asters and carnations has been successfully carried on at one or two points. The soil is inclined to be droughty. Organic manures are of much benefit.

The following table gives the results of mechanical analyses of the fine earth of the soil and subsoil:

Mechanical analyses of Dunkirk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
16094.....	Soil	5.5	20.6	18.2	20.4	8.5	16.6	10.1
16095.....	Subsoil.....	3.0	20.8	23.4	38.2	4.5	6.1	4.4

CLYDE FINE SANDY LOAM.

The surface soil of the Clyde fine sandy loam consists of a dark-gray, brown, or black fine sand or light-textured fine sandy loam, varying in depth from 10 to 14 inches. The subsoil is a yellow or gray fine sand or fine sandy loam, though in a few instances this gives place to a light loam at 30 to 36 inches. The Clyde fine sandy loam contains a high percentage of organic matter, which renders it loamy, mellow, and easy to cultivate, and imparts to it the characteristic dark color.

With the exception of a few small areas, the type occurs almost exclusively north of the Niagara escarpment. It is typically developed in the largest area in the county which is located southeast of Newfane. Here the type is closely associated with the Dunkirk fine sandy loam, the chief difference being one of drainage conditions.

In general the surface is level to slightly undulating. Small knolls and low ridges of Dunkirk fine sandy loam occur scattered throughout the type and form one of its characteristic topographic features. These small knolls are generally circular or elliptical in shape and range from a fraction of an acre to 10 acres in extent. It being impossible to represent such small areas upon the map, they have been classed with the Clyde fine sandy loam.

In the vicinity of Ransomville the type occurs in the form of low ridges, which represent the naturally better drained portions of the soil. Taken as a whole the type is at present fairly well drained, notwithstanding its original marshy condition and nearly level topography. The native vegetation consisted largely of black ash, alder, huckleberry, cranberry, and tamarack. The loose, porous nature of both soil and subsoil admits the water to the lower depths, and only after the heaviest rains does water remain upon the surface for any great length of time. In level areas and depressions, where drainage is most deficient and where the soil inclines toward compactness, tile drains would be of much value.

The Clyde fine sandy loam, when occurring in the form of low ridges, consists of wind-blown beach deposits. The more level portion, which is by far the greatest in extent, owes its origin to reworked glacial sands which have been subjected to poorly drained or swampy conditions. This method of formation, therefore, gives the type its high content of organic matter.

The Clyde fine sandy loam is one of the most desirable truck soils of the area. It is admirably adapted to small fruits and vegetables. Cabbage, tomatoes, peas, beans, cucumbers, and potatoes are the principal crops grown, several of which find ready market at the canning and preserving factories located within the county. It is

not a desirable peach soil, but where drained apples and pears do fairly well.

Where general farming is practiced the yields are somewhat lighter than upon the Clyde loam. Corn yields on an average from 30 to 60 bushels per acre; wheat 20 bushels; oats 25 to 50 bushels, and beans 14 to 20 bushels. A large acreage of hay is grown, with yields varying from 1 ton to 2 tons per acre. Liberal applications of stable manure are required to maintain its natural productivity and organic content.

The average results of mechanical analyses of this type of soil are given in the following table:

Mechanical analyses of Clyde fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
16078, 16080.	Soil	0.2	1.6	1.4	38.4	27.0	26.3	5.1
16079, 16081.	Subsoil.....	.2	1.1	1.5	40.8	35.4	15.9	5.5

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16081. 4.41 per cent.

CLYDE LOAM.

The surface soil of the Clyde loam to a depth of from 8 to 15 inches ranges from a dark-gray to black heavy sandy loam to a heavy loam. The subsoil is a gray or yellow and gray mottled loam or clay loam, somewhat silty and usually streaked with iron stains or the pink color derived from the red Medina shale.

The Clyde loam in Niagara County occurs in two phases, with slightly different agricultural value. The soil most typically representing the Clyde series possesses decidedly clayey properties and occupies low, level, poorly drained positions. This phase is free from stone and gravel. The soil is a heavy black loam and in some instances a clay loam, with an accumulation of organic matter upon the surface. The natural drainage is poor, but has been improved to a great extent by the construction of open ditches. While surface drainage is fairly well established, tile drains would be found very satisfactory and could be used to great advantage.

The other phase, representing at least two-thirds of the Clyde loam mapped in Niagara County, consists of a light loam or heavy, sandy loam, usually of a grayish-brown color. In appearance it resembles a stony loam, and often as high as 50 per cent of stone and gravel is present on the surface. Both soil and subsoil contain considerable stone. Partially rounded as well as angular fragments of sandstone and limestone make up the bulk of the stony material. Granitic boulders are often present. This phase of the type was mapped to

embrace all the dark-colored material between the Clyde fine sandy loam and Clyde clay. There are, therefore, many minor variations resulting from different topographic positions and a consequent difference in texture, drainage, organic-matter content, and agricultural value. The stony phase occupies level to gently rolling country and carries a lower percentage of organic matter. Owing to its slightly higher position and looser texture it is better drained than is the phase devoid of stone.

The phase first discussed occupies glacial-lake beds and depressions, and is composed of the finer grades of glacial material washed in from the higher land. This material remained for a long period in a swampy condition. The stony phase represents low-lying glacial material, the discoloration of which is due to submergence and restricted drainage. It has also received some wash, but the marshy conditions were less pronounced than in the first phase. As originally deposited the greater part of the material was essentially the same as that forming the Dunkirk loam, the modification resulting from the subsequent conditions to which it was subject.

The Clyde loam occupies 15.8 per cent of the entire survey. While it occurs in nearly every part of the county it is most extensively developed on the Ontario plain, where it is the prevailing type. Its continuity, however, is much broken by smaller areas of other types. The area of the type on the Erie plain is small. The areas in Royalton, Pendleton, and Cambria townships are comparatively free from stone and small areas within the stony areas are frequently devoid of stone and gravel.

In wet seasons crops are frequently drowned out where drainage is deficient. Much of the type is susceptible of improvement through the establishment of tile drains.

General farm crops are successfully produced on well-drained and properly cultivated parts of the Clyde loam. Corn, the leading crop, yields from 40 to 80 bushels per acre, oats 40 to 60 bushels, wheat 15 to 30 bushels, beans 20 to 30 bushels, and hay 1 ton to 2 tons. Much larger yields of all these crops have been produced under special conditions of drainage and seasons. It is the leading corn soil of the county. The low, poorly drained areas are devoted principally to hay and pasture. Apples, pears, and plums are successfully produced upon the high-lying stony portions. Large quantities of truck and canning crops are grown. The soil is well adapted to cabbage.

Stable manure is used to a limited extent. No particular crop rotation is practiced. A rotation quite extensively used covers a period of five years and consists of corn, beans, or potatoes, followed by oats, wheat, and hay for two years. For the improvement of this type better drainage is a prime essential.

The average results of mechanical analyses of fine-earth samples of the Clyde loam are shown in the following table:

Mechanical analyses of Clyde loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
16074, 16076.....	Soil	0.5	2.7	2.3	16.3	24.1	39.2	14.1
16075, 16077.....	Subsoil.....	.3	1.9	1.7	12.8	21.4	47.8	14.1

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16075, 1.04 per cent.

HUNTINGTON LOAM.

The typical Huntington loam of Niagara County consists of a brown silty loam about 12 inches deep, underlain by a similar loam that rests upon a sandy loam. In some areas the soil varies to a sandy loam.

The type is of small extent, the largest and most representative bodies occurring in the bows of Tonawanda Creek. It is also found occupying the abandoned river channel northeast of Lockport, where it is somewhat sandy and gray in color. Narrow strips are also mapped along many of the small streams, and these show considerable variation in texture. A few isolated bodies occupying depressions were also mapped.

Much of the type is subject to overflow and is left to grass. It has been formed from the deposits of streams at times of overflow. Some of the areas are almost entirely above flood. When cultivated, corn, potatoes, and beans are the principal crops, with an occasional field of oats and wheat. Corn will yield from 50 to 75 bushels per acre, and under favorable conditions as much as 100 bushels has been produced. Potatoes yield from 75 to 150 bushels, and beans 15 to 25 bushels per acre. Wheat and oats yield proportionately well, the latter succeeding best. The soil is productive, and in situations favorable to market truck and canning crops would doubtless prove highly profitable.

The results of mechanical analyses of soil and subsoil of this type are given in the following table:

Mechanical analyses of Huntington loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
16135.....	Soil	0.2	0.3	0.2	1.5	9.1	67.8	20.5
16136.....	Subsoil.....	.0	.0	.0	1.6	18.9	60.7	17.9

MEADOW.

Meadow includes narrow strips of waste land along the Niagara River and smaller streams, and also a few low-lying areas in the upland. It represents land wet and unfit for cultivation, but usually affords some pasture. The Meadow is frequently poorly drained material similar to Huntington loam. The low-lying areas are partially covered by water most of the time, though in summer they often become dry. The swampy areas of the type usually support a rank growth of ferns, rushes, and water-loving grasses.

MUCK.

Muck consists of plant remains decayed to a point where vegetable tissues are not distinguishable. The material at this stage assumes a black or brown color, and is of a friable or pasty character when wet. When dry it contracts greatly, but does not become particularly hard. The areas are naturally wet and swampy, the conditions favoring a heavy growth of plants which fall down to form Muck and Peat, the latter representing a less advanced stage of decay, where plant tissues are easily recognizable. Upon the fallen remains a dense growth of new plants may thrive, thus adding to the deposit until it attains a depth of many feet. In Niagara County this material has decomposed in most places to the condition of true Muck, but may frequently be underlain by Peat, and this sometimes reaches the surface.

Several good-sized areas of Muck occur in the county. The more important of these are southwest of Middleport, east of North Hartland, east of Ridgeroad, northwest of Warrens Corners, and northwest of Sanborn. In the main they occupy rather flat depressions, which were probably at one time lakes. The Muck generally rests on a rather dense clay formation, but a layer of gray sand may intervene. During the accumulation of the Muck more or less mineral matter was washed in and is found mixed with the organic matter, imparting a gritty texture and forming a bulky ash when burned.

The Middleport area consists of 2 or 3 feet of Muck overlying a peat in the deeper central part. During the present year something over a hundred acres of this soil has been purchased by a New York company, and a number of acres have been cleared and planted to onions, lettuce, celery, and cabbage. Some remarkably good crops were produced and the results show clearly the value of certain fertilizers on this area. Both a complete mixture consisting of 4 per cent of nitrogen, 8 per cent phosphoric acid, and 10 per cent of potash, and potash alone were used in amounts of 1,000 to 1,500 pounds per acre. The increase in the yield and quality of the prod-

uct was very great, the potash proving much the most effective element. In this regard the results agree with those generally obtained in fertilizing Muck soils. The crops will also tend to improve with the length of cultivation given the soil, as shown by the fact that a small area formerly cleared gave the best results.

The remaining areas have been very little cleared or cultivated. The Ridgeroad area is quite peaty and much of it is barren of vegetation. For several years it has been run over by fire, which destroyed it to the level of saturation, leaving a gray ash.

Drainage is the first essential in bringing about cultivation. In the Middleport area a large open ditch was cut through the barrier to drainage and laterals extended to different parts of the Muck area, cutting it into blocks. This permits rapid and complete drainage. Compacting methods of cultivation are practiced on this Muck soil.

SUMMARY.

Niagara County is located in the western part of New York in the angle between Lake Ontario and the Niagara River. The surface consists of two generally level plains separated by a rather steep, north-sloping escarpment about 200 feet in height. These are known as the lower or Ontario plain and the upper or Erie plain. The elevation of the former is from about 300 to 400 feet and of the latter from about 580 to 640 feet.

On the Erie plain the drainage is by a few short streams southward into Tonawanda Creek, which forms the county line. On the Ontario plain are several sluggish streams emptying into the lake. Their lower reaches are very broad and somewhat stagnant and were probably formed in early post-glacial time.

The northern two-thirds of the county is occupied mainly by people of English extraction and the southern third mainly by Germans. Settlement is quite dense except in the southern part of the county. It is concentrated along a number of main roads. Some of these are the Lake Road, Hess Road, Creek Road, Ridge Road, and Lower and Upper Mountain roads. The chief towns are Lockport, Niagara Falls, and North Tonawanda. Buffalo is a few miles south of the area.

The mean annual temperature is about 47.5° F. The maximum range recorded is from 99° F. to -12° F. Lake Ontario exercises an equalizing influence on the climate within several miles of its shore. Prevailing winds are westerly and southwesterly. Length of growing season between killing frosts is about one hundred and seventy days, from the last four days of April to the 16th of October. Snowfall is greatest in the southern half of the county.

Transportation facilities are generally good, particularly for outside shipments. Markets are very good. The region has a wide reputation for fruit production and attracts many buyers. This demand is increased by local storage plants of large capacity and by canning, drying, and preserving plants.

Agricultural settlement began in 1802. For a few years following 1812 it decreased, after which it again became active. The completion of the Erie Canal through the area in 1825 was a great stimulus to industrial activity and agricultural interests by affording an outlet for products.

The leading crop in the first half of the nineteenth century and, indeed, until well into the second half was wheat. Live stock was also raised in larger numbers than at present. Sheep raising was prominent from 1850 to 1870.

Commercial fruit production began with apples about 1850 or 1860. This success stimulated the planting which forms the basis of the present large production. Other fruits, peaches, pears, plums, etc., began to be largely planted about 1875. Following the marked increase in orchard acreage came increased injury from insect and fungus enemies. The outlook for orchard fruits, however, was reassured by the introduction of spraying methods about 1892.

Two types of agriculture prevail at present. In the southern part of the county and other places where especially heavy soil prevails, grain and hay farming is practiced. In the central and northern parts fruit raising is the chief business, supplemented by grain farming. As a rule, fruit finds place only on the loams and lighter soils of good drainage, while heavy soils are used for hay and grain.

No rotation is strictly adhered to. The general practice is to put sod land to a cultivated crop like corn, beans, or potatoes, followed by oats and wheat, and in the latter timothy and clover is seeded and occupies the land for from two to five years. On the heavy soils the cultivated crops are reduced or excluded and the other crops may be repeated, followed by an occasional fallow.

The average size of farms is 70 acres. About 60 per cent of the farms are operated by the owners. Eighty-three per cent of the land in the county is improved. The value of farm land ranges from about \$40 for the most remote clay or marshy land to from \$100 to \$125 for the best mixed farms and from \$200 to \$300 for bearing orchard land.

The soils have been formed under glacial lake influence and are related to large areas of soil around the Great Lakes. Many of the types are of large extent in New York, Ohio, Michigan, and westward.

Two main soil series occupy nearly all of the county. These are the Dunkirk and the Clyde. The former includes all light-colored and moderately well drained materials, while the latter represents soils which were originally laid down in the same way as the Dunkirk, but which have been modified by poor drainage conditions, resulting in accumulations of organic matter and wash and their dark or black color. The Clyde soils are of large extent.

Seventeen types of soil are recognized. Of these eight belong in or with the Dunkirk series and three in the Clyde series. The others are miscellaneous types due to local conditions, such as rock outcrops, recent alluvium, and meadow.

Four types are clay or clay loam, five types are loam or silt loam, and five types are sandy loam or sand. The clays and loams are of largest extent. In respect to the distribution of soils three belts extending east and west across the county may be recognized. These are, 1st, in the southern part, a predominance of heavy clay soils; 2d, the central third consisting of undulating loams and sandy loams with some rough lands; 3d, on the Ontario plain a comparatively flat region where Clyde soils of the loam and sandy loam grades predominate.

The Clyde soils are the best corn land. For this crop the clay may be improved by drainage and deeper plowing.

The best apple soil is the Dunkirk loam, closely seconded by Dunkirk silt loam, Dunkirk fine sandy loam, and Dunkirk gravelly sandy loam.

For peaches and cherries the lighter sandy loams give better results than for apples and they succeed very well on the loam. Cherries are most extensively grown on the Dunkirk gravelly sandy loam along the Ridge Road.

Pears, plums, and quinces grow best on the Dunkirk loam and Dunkirk clay loam. Small fruits and melons are grown on the sandy loams and silt loam.

The flavor, color, and keeping quality of apples and pears are better on the Dunkirk loam than on lighter or heavier soils. On the heavy soils the chief difficulty is lack of drainage.

The most general and pressing soil problem is the need of better drainage. All of the Clyde types and many of the other types are in need of this.

Farmers need to study more carefully the beneficial results to be had from good drainage to the end that they may cooperate more fully to increase the number of large open ditches for outlet purposes.

A great many of the surface ditches now generally used for drainage may well be replaced by tile placed below 2 feet. On the heavy clays the penetration of water to the tile may be increased by

the construction of sinks and catch basins of stone, brush, and other porous materials. Sufficient tile of good quality may be manufactured in the county from the subsoil of Dunkirk clay and Clyde clay.

All the light-colored types need more organic manures. Farmyard manures should be supplemented by catch crops turned under for green manure. Rye, buckwheat, crimson clover, and even weeds may be used.

Crop rotation should be more closely adhered to. Roots will be found useful on many farms on heavy and low-lying soils. The average depth of plowing should be increased on all except the sandy soils. On the Dunkirk loam and Dunkirk silt loam alfalfa will thrive and should be more largely grown where forage and hay are needed.

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