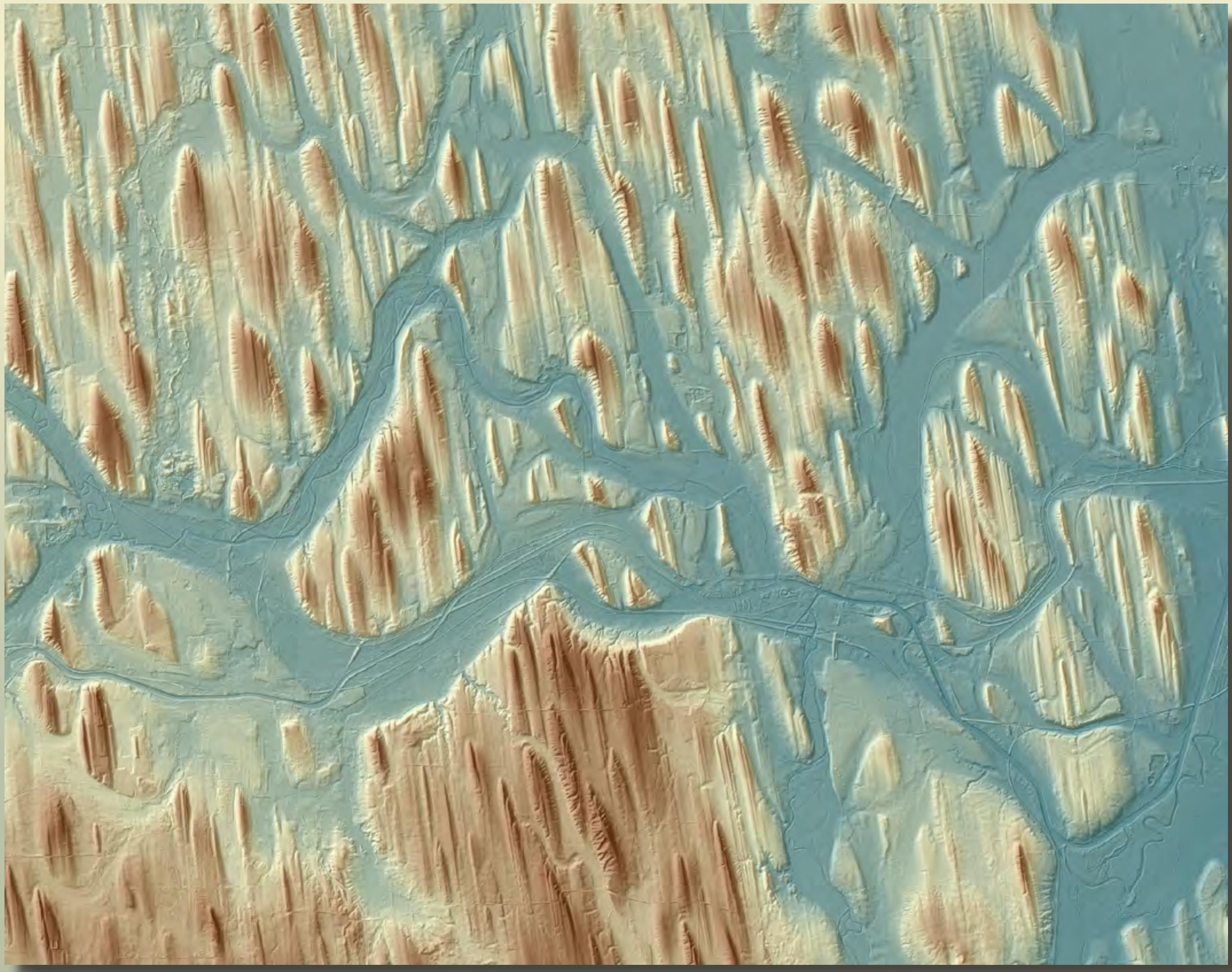
Prepared in cooperation with the New York State Department of Environmental Conservation

Hydrogeology of Aquifers Within the Fairport-Lyons Channel System and Adjacent Areas in Wayne, Ontario, and Seneca Counties, New York



Scientific Investigations Report 2021–5086

U.S. Department of the Interior
U.S. Geological Survey

Cover. Lidar hillshade with colored elevation gradient (brown is high, blue-green is low) of south-central Wayne County, New York, showing drumlins, a subglacial drainage path with eskers (northwestern corner), and reaches of the Fairport-Lyons channel between Newark and Lyons, N.Y. Image by the U.S. Geological Survey.

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By Richard J. Reynolds, Paul M. Heisig, and Kristin S. Linsey

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Flow rate	
gallon per minte (gal/min)	0.06309	liter per second (L/s)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
	Specific capacity	
gallon per minute per foot ([gal/min]/ft)	0.2070	liter per second per meter ([L/s]/m)
	Hydraulic conductivity	
foot per day (ft/d)	0.3048	meter per day (m/d)
	Transmissivity	
foot squared per day (ft^2/d)	0.09290	meter squared per day (m^2/d)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F = (1.8 × °C) + 32.

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C = (°F – 32) / 1.8.

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83) and the World Geodetic System of 1984 (WGS 84).

Elevation, as used in this report, refers to distance above the vertical datum.

Supplemental Information

Concentrations of chemical constituents in water are given in milligrams per liter (mg/L).

Abbreviations

EPA	U.S. Environmental Protection Agency
lidar	light detection and ranging
NWIS	National Water Information System
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
SSURGO	Soil Survey Geographic database
USGS	U.S. Geological Survey

Hydrogeology of Aquifers Within the Fairport-Lyons Channel System and Adjacent Areas in Wayne, Ontario, and Seneca Counties, New York

By Richard J. Reynolds, Paul M. Heisig, and Kristin S. Linsey

Abstract

A hydrogeologic investigation was undertaken by the U.S. Geological Survey, in cooperation with the New York State Department of Environmental Conservation, within the areas shown in the Macedon, Palmyra, Newark, and Lyons 7.5-minute quadrangle maps that include parts of Wayne, Ontario, and Seneca Counties in New York. The most productive zone of aquifers within the study area is associated with the Fairport-Lyons glacial-stream channel (hereinafter referred to as the "Fairport-Lyons channel") in southern Wayne County and adjacent areas. The Fairport-Lyons channel is a west-east-oriented bedrock channel that once served as the outlet for glacial Lake Dawson, which occupied the Genesee Valley near Rochester during the Pleistocene. The Fairport-Lyons channel and intersecting subsidiary channels are hereinafter referred to as the "Fairport-Lyons channel system." Glacial meltwater eroded this shallow channel network into the underlying bedrock, and the channels subsequently filled with interlayered glaciofluvial sand and gravel and fine-grained lacustrine deposits. These sand and gravel deposits provide the only large supplies of groundwater in Wayne County under unconfined and confined conditions and serve a population of over 20,000 through a combination of domestic and municipal water supply wells. The largest reported well yield, 1,200 gallons per minute, is from an industrial supply well near Newark, N.Y. Much of the sand and gravel within the Fairport-Lyons channel system is generally thinly saturated; however, in three areas—near Macedon, Newark, and Lyons, N.Y.—the saturated thickness of the aquifer is sufficient to support groundwater yields adequate for municipal and industrial use, in part because of induced infiltration from the Erie Canal.

Introduction

During the 1980s, the U.S. Geological Survey (USGS), in cooperation with the New York State Department of Environmental Conservation (NYSDEC), the New York State Department of Health (NYSDOH), and the U.S. Environmental Protection Agency (EPA), mapped the hydrogeologic framework, aquifer boundaries, potentiometric surface, well locations, and aquifer thickness of many major aquifers in the State ("Primary and Principal aquifers" as designated by NYSDEC). Since 1983, NYSDEC has been the sole cooperating State agency in this aquifer mapping program. To date, more than 40 aquifer map reports have been published. These reports have been used by New York State to develop aquifer protection programs and support many NYSDEC Division of Water activities, including delineation of contributing areas to wells, assessing potential aquifer vulnerability from point and nonpoint contaminant sources, responding to contaminant spills or leaks from underground fuel storage facilities, and providing information to assess permit applications for land uses that may affect the principal and primary aquifers. This study of the sand and gravel aquifers associated with the Fairport-Lyons glacial-stream channel (Griswold, 1951) (hereinafter referred to as the "Fairport-Lyons channel") and intersecting subsidiary channels in Wayne County and parts of Ontario and Seneca Counties (hereinafter referred to as the "Fairport-Lyons channel system") is the latest report from this long-term cooperative effort between the USGS and the NYSDEC.

Many of the communities (fig. 1) that were founded along the Erie Canal (plate 1) in southern Wayne County during the early 19th century have undergone significant development and population growth since their establishment; the Erie Canal is one of four canals that compose the New York State Barge Canal (National Park Service, 2021). The primary source of groundwater in southern Wayne County (New York State Department of Health, 1982) (table 1) is derived mostly from wells that tap sand and gravel aquifers associated with the Fairport-Lyons channel system, whereas domestic supplies rely on wells drilled into shallow bedrock or scattered glaciofluvial gravel deposits. The hydrogeologic setting in this area—the Ontario Lowlands—is different from the dissected Appalachian Plateau to the south in that productive sand and gravel aquifers within and among the drumlin fields in Wayne County are relatively scarce. Because of this, the Wayne County Water and Sewer Authority was created in 1987 by State legislation to coordinate and manage the consolidation of water supply and transmission within Wayne County and to plan for future improvements to enhance water availability within the county (Wayne County Water and Sewer Authority, 2016). Since its creation, the authority has diversified its water supplies to rely more on surface-water supplies, such as Lake Ontario and Canandaigua Lake, and less on groundwater supplies for its water service areas.

The study area (fig. 1) includes the areas covered by the 1:24,000-scale quadrangle maps of Macedon, Palmyra, Newark, and Lyons, which encompass southern Wayne County and the northern parts of Ontario and Seneca Counties, N.Y. The Fairport-Lyons channel is a west-east-oriented bedrock channel that served as an outlet for glacial Lake Dawson (Fairchild, 1909), which occupied the Genesee Valley and the western end of the present-day Lake Ontario basin when the retreating ice margin was in northern Wayne County near Rochester toward the end of the Pleistocene. Glacial meltwater eroded this shallow channel into the underlying bedrock, and the channel was subsequently partly filled with glaciofluvial sand and gravel and fine-grained lacustrine sediments. These glaciofluvial deposits provide the only large supplies of groundwater in Wayne County under confined and unconfined conditions. The largest reported well yield in Wayne County is 1,200 gallons per minute (gal/min) from an industrial supply well in the Fairport-Lyons channel near Newark, N.Y. (Griswold, 1951). Crain (1974) reported that gravel aquifers in much of the Fairport-Lyons channel system are thin and shallow; however, in three areas—east of Macedon, N.Y., at Newark, and at Lyons—the aquifer thickness is sufficient to support groundwater yields adequate for municipal and industrial use, in part because of induced infiltration from the Erie Canal (plate 2).

Data Sources and Methods

Well records from well inventories associated with earlier USGS groundwater studies of Wayne and parts of Seneca and Ontario Counties (Griswold, 1951; Crain, 1974) were compared with existing well entries in the USGS National Water Information System (NWIS) database (U.S. Geological Survey, 2021), and corrections were made, as needed, for location, elevation, construction details, well yields, and water levels by using data from original well inventory field maps and inventory forms. More recent well data, supplied by the NYSDEC's Water Well Program, were verified as to location and added to the NWIS database; the driller's logs from these wells were also added to each well's respective geographic information system attributes. Logs of test borings located along State highways and the Erie Canal were supplied by the New York State Department of Transportation (NYSDOT). These data were verified as to location and land-surface elevation and were added to the NWIS database.

Geologic and driller's logs from the well data were used in constructing six hydrogeologic sections that illustrate the distribution of glacial deposits and the general water table position from which unconfined and confined aquifers within the study area can be inferred (plate 2). The well records compiled for the study area are detailed in a U.S. Geological Survey data release (Reynolds and others, 2022). The surficial geology and areas with aquifer potential depicted in plate 1 were delineated from well data, Soil Survey Geographic database (SSURGO) digital data (U.S. Department of Agriculture, 2008), and light detection and ranging (lidar) imagery.

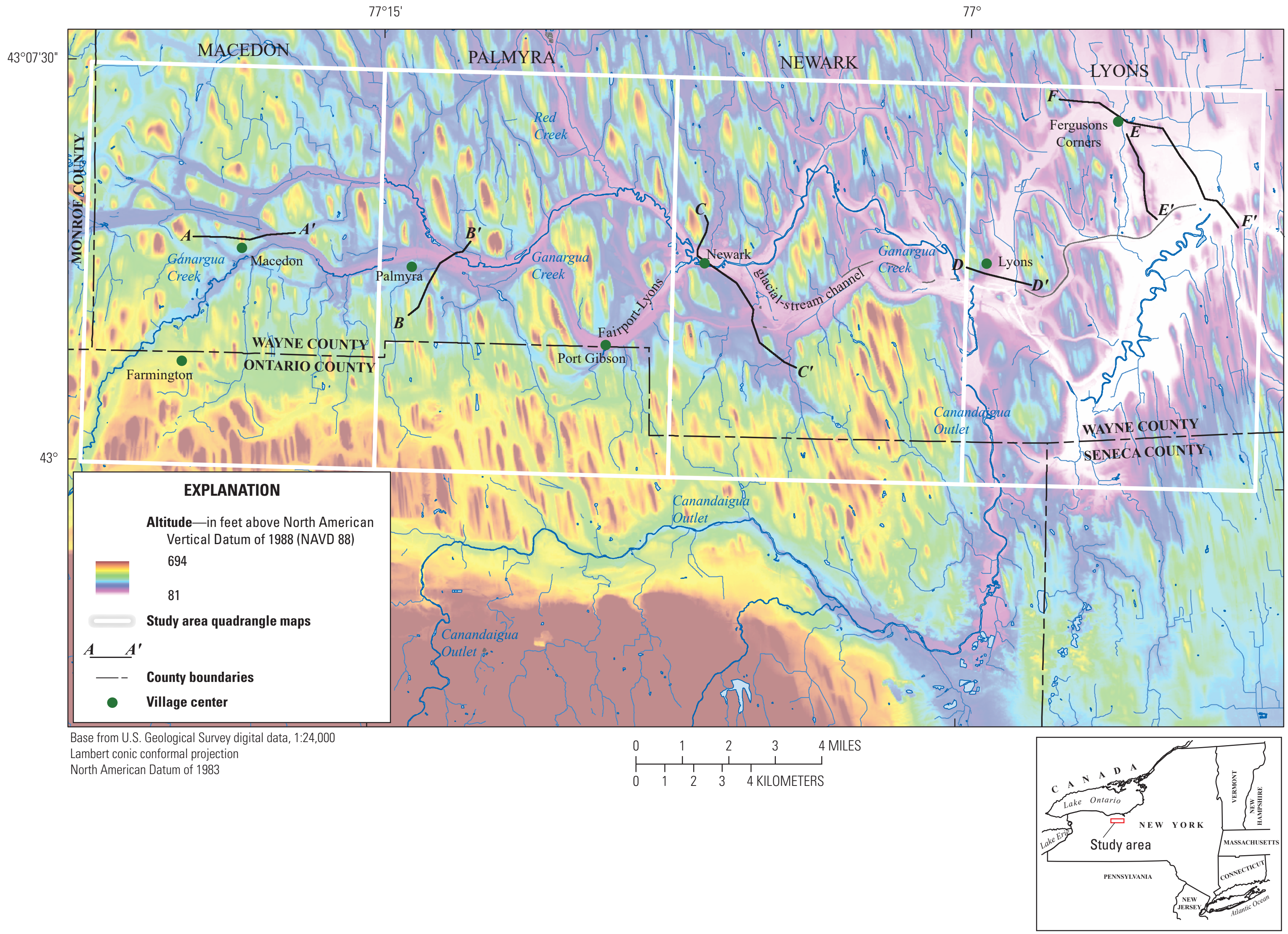


Figure 1. The extent of the study area, including the Fairport-Lyons glacial-stream channel and intersecting channels (Fairport-Lyons channel system), quadrangle outlines, hydrogeologic sections, and relative land-surface elevations. Additional base-map data from U.S. Geological Survey (2015) for Wayne and Seneca Counties, from Pictometry International (2006a) for Monroe County, and from Pictometry International (2006b) for Ontario County.

Table 1. Major groundwater users in Wayne County, New York.

[Data are from New York State Department of Health (1982)]

Water users	Source	Population served
Lyons	Wells and Junius Ponds	4,600
Newark	Wells and Canandaigua Lake	12,000
Macedon	Wells	1,800
Nonmunicipal community supplies	Wells	1,200
Individual homeowners	Wells	Estimated 1,000
	Total	**20,600**

Deglacial History

The deglaciation of Wayne County, N.Y., has produced many notable glacial landforms, including drumlins, beach ridges, and drainage channels. Central New York was the location of numerous glacial lake stages that abutted the southern terminus of the receding Ontario ice lobe. Fairchild (1909) postulated a series of 10 successively lower glacial lakes in central New York. These lake stages were

1. Lake Watkins—This body of water occupied the four largest Finger Lakes valleys with an outlet at an elevation of 900 feet (ft) near Elmira, N.Y.

2. Lake Newberry—An expanded stage of Lake Watkins, with an outlet at an elevation of 1,000 ft near Elmira.

3. Lake Hall—A successor to Lake Newberry, with outlets draining westward past Batavia, N.Y., which is about 50 miles (mi) west of the study area, with elevations starting at 1,000 ft and decreasing to 900 ft.

4. Lake Vanuxem—A successor to Lake Hall, with an outlet near Syracuse. N.Y., about 50 mi east of the study area, to the Mohawk-Hudson River drainage at an elevation of 900 ft, and eroding downward to extinction.

5. Free drainage—An episode of free eastward drainage through the Batavia-Victor east-west drainage way (about 6 mi south of and parallel to the Fairport-Lyons channel) to the head of the Mohawk drainage at Rome, N.Y., which is about 90 mi east of the study area. Ice covered the entire Fairport-Lyons channel system during the free-drainage episode.

6. Lake Vanuxem (second stage)—A second stage of Lake Vanuxem, with a drainage threshold at an elevation of 900 ft.

7. Lake Warren—Lake Warren, which was located about 60 mi west of the study area in the Lake Erie basin, expanded eastward to merge with Lake Vanuxem, but with an outlet that drained westward to the Mississippi River at an elevation of about 880 ft.

8. Lake Dana—A recession of the ice front at Syracuse gave the westward-draining Lake Warren an eastward outlet to the Mohawk-Hudson River system. The Lake Dana stage was followed by a significant drop of lake level from this stage (hyper-Iroquois) at an elevation of 700 ft to the final Lake Iroquois lake stage at 440 ft.

9. Lake Dawson—With the ice front north of the present-day location of the Fairport-Lyons channel, Lake Ontario water continued flowing eastward and filled the Irondequoit River Basin near Rochester, N.Y., which is about 20 mi northwest of the study area. Multiple outlets at Fairport with an elevation of 480 ft allowed lake overflow to escape eastward toward the proto Lake Iroquois. The floodwaters carved a shallow trench in the soft underlying Salina Formation shales from Fairport eastward to Lyons, where the water emptied into Lake Iroquois, which stretched from Syracuse to Rome, where it exited into the Mohawk River Basin. Recent lidar images show that the Fairport-Lyons channel extends eastward across adjacent central Cayuga County (Bird and Kozlowski, 2014b).

10. Lake Iroquois—At this stage, eastward drainage had ceased though the Fairport-Lyons channel. However, Lake Iroquois, at an elevation of 440 ft, extended eastward from Lyons to Rome, with an arm of the lake backing up into the Fairport-Lyons channel as far west as Palmyra.

The Fairport-Lyons channel begins at Fairport, N.Y., about 5 mi west of the present study area, at an average elevation of 480 ft, and ends 26 mi away at Lyons, at an elevation of 400 ft. During the Lake Dawson phase, there were three lake outlets at Fairport, with elevations ranging from 462 to 483 ft (Muller and others, 1988). All three of these outlets join to the east of Fairport and were probably briefly functioning simultaneously. The lowest channel, at an elevation of 462 ft, was the last to cease flowing when recession of the ice margin resulted in abandonment of the Fairport-Lyons channel; part of the Erie Canal crosses this abandoned part of the channel. East of Palmyra, the channel splits but reunites 1 mi further east, then immediately divides again and surrounds a drumlin field about 3 mi in diameter, reuniting 2 mi northwest of Newark. This northern branch of the Fairport-Lyons channel now carries Ganargua Creek and is filled with till and lacustrine sediments. Fairchild (1909) cites this northern channel as an example of a meltwater channel created from previous meltwater episodes (pre-Lake Dawson) that did not carry the large volumes of water from the Lake Dawson drainage episode (Fairchild, 1909). Withdrawal of the ice margin further north presumably allowed Lake Dawson to expand somewhat west beyond Rochester, N.Y. (Fairchild, 1909). Before the ice margin could recede much farther, however, Lake Dawson was succeeded by the earliest phase of Lake Iroquois that was expanding westward in the Lake Ontario basin (Muller and Prest, 1985). Fairchild (1909) describes an arm of Lake Iroquois that backed up into the Fairport-Lyons channel as far west as Palmyra. As the ice front receded north of the Fairport-Lyons channel, meltwater draining southward though inter-drumlin channels carried fine-grained sediments eroded from till and deposited them as lacustrine sediments into this arm of Lake Iroquois that occupied the Fairport-Lyons channel. This resulted in as much as 40 ft of silt and clay in some places being deposited over previously deposited sand and gravel.

As the continental ice sheet retreated northward from the Appalachian Plateau, subglacial channels (which had previously transmitted pressurized meltwater southward to major valleys on the Plateau) continued to function. Sand and gravel were deposited along these channels to form eskers and associated ice-contact landforms. Two lines of nearly continuous ice-contact deposits that now extend from north to south across the study area, one through Palmyra and the other through Newark (plate 1), mark the route of two persistent subglacial channels. Similar subparallel north-south lines of ice-contact deposits are found across the Ontario Lowlands (Randall, 2001); the locus of gravel deposition within these subglacial channels shifted northward ahead of the retreating ice margin, while finer sediments generally were deposited in proglacial lakes beyond the ice margin. Scant records of wells in these two lines of ice-contact deposits were assembled for this study, but it appears that the sand and gravel is largely unsaturated in most places.

In the southern part of the Macedon quadrangle, several areas that are mapped as sand and gravel have flat surfaces ranging from 570 to 600 ft in elevation. These areas lie immediately north of inter-drumlin valleys or saddles that open southward into a broad valley with a flat swampy floor at about 575 ft in elevation, and this broad valley is drained eastward by Black Brook into Canandaigua Outlet. To the west, this broad valley aligns with another broad valley segment, also at about 570 ft in elevation, just south of Victor, N.Y., which is about 10 mi southwest of the study area. This valley also aligns to the west on the Honeoye Falls quadrangle (west of the study area) with another broad east-west valley with a flat floor at 570–580 ft in elevation; both valleys are now drained eastward and westward by small streams. These now-abandoned east-west channel segments compose the Batavia-Victor channel, which was a predecessor to the Fairport-Lyons channel. An ice dam or temporary moraine dam in this channel impounded a large proglacial lake in the western Lake Ontario lowland and Lake Erie lowland, whose water surface was no less than 570 ft in elevation (Fairchild, 1909). The sand and gravel areas mapped in the southern Macedon and southwestern Palmyra quadrangles are mostly kame deltas (or subaquatic fans) built into ponded water at elevations controlled by water levels in the Batavia-Victor channel and deposited somewhat later than the ice-contact deposits mapped nearby, which formed in crevasses when most of the landscape was still ice-covered. Eventually the exposure of the saddle into the Mohawk River Basin at Rome led to the establishment of proglacial Lake Iroquois and the lowering of base level in the Macedon/Palmyra/Newark quadrangles by about 100 ft; drainage southward to the Batavia-Victor channel ceased, and kame deltas were built at 510 ft in elevation near Macedon, declining eastward and later decreasing to elevations of 430–420 ft.

Northward retreat of the ice sheet exposed spillways at Fairport at elevations ranging from 483 to 462 ft (Muller and others, 1988). The elevation of a large proglacial lake that extended westward from Fairport about 100 mi or more was abruptly lowered about 100 ft (Fairchild, 1909), which presumably generated a large, prolonged flood through these new spillways, thus carving the Fairport-Lyons channel.

Surficial Geology

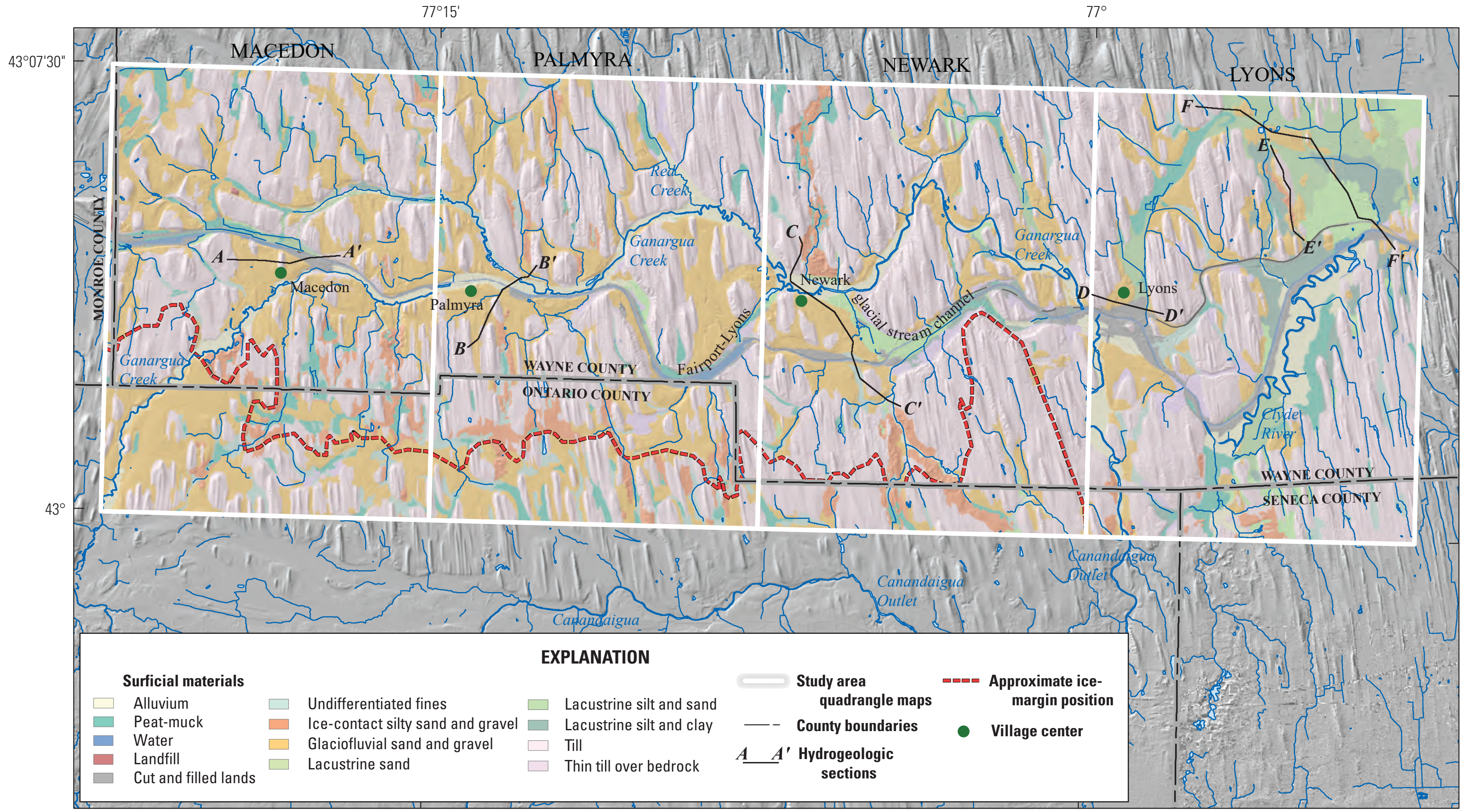
Plate 1 is a map of the surficial geology (the unconsolidated glacial and postglacial sediments above bedrock) in the four 7.5-minute quadrangles that compose the study area (Macedon, Palmyra, Newark, and Lyons). The surficial geology was compiled primarily from SSURGO data (U.S. Department of Agriculture, 2008) and well log data and was augmented from published and unpublished field maps on file with the USGS and a recently published map by the New York State Geological Survey (Bird and Kozlowski, 2014a). The parent material codes in the digital soils data were plotted at 1:24,000 for each quadrangle and were color coded to represent the major surficial geologic units. The boundaries of these units were then adjusted as needed, based on comparisons with well logs and with lidar shaded relief and elevation data. Figure 2 also shows the location of a probable past ice margin.

Till

Till is a compact, unsorted mixture of clay, silt, sand, gravel, and boulders (Neuendorf and others, 2005). Till is present in two forms in the study area—as ground moraine and as drumlins. Till in the area is silt- and clay-rich because the ice likely eroded and incorporated previously deposited lake deposits and underlying shale bedrock.

Ground Moraine

Ground moraine consists of an unsorted mixture of clay, silt, gravel, and some boulders that was deposited as a thin layer of lodgment and (or) ablation till over the underlying shale bedrock by glacial ice (Neuendorf and others, 2005). It is commonly overlain by colluvium, lacustrine sediments, or sediments that were eroded from drumlin till by glacial meltwater.



Base from U.S. Geological Survey digital data, 1:24,000
Lambert conic conformal projection
North American Datum of 1983

0 4 8 MILES
0 4 8 KILOMETERS

Figure 2. The extent of the study area, including the Fairport-Lyons glacial-stream channel and intersecting channels (Fairport-Lyons channel system), quadrangle outlines, distribution of mapped surficial geologic units, and location of past ice margin. Additional base-map data from U.S. Geological Survey (2015) for Wayne and Seneca Counties, from Pictometry International (2006a) for Monroe County, and from Pictometry International (2006b) for Ontario County.

Drumlins

Drumlins are the most conspicuous glacial features in the Fairport-Lyons channel study area. Drumlins are primarily elongated hills composed mostly of glacial till, which were often deposited directly on shale bedrock by the glacier (Neuendorf and others, 2005). Within the study area, they range in height from less than 20 ft to over 180 ft, with most drumlins having heights between 100 and 150 ft. The length and width of drumlins vary widely—smaller drumlins are from 0.2 to 0.3 mi long and 0.1 mi wide, while larger ones may be as much as 1.5 mi long and 0.5 mi wide. Drumlins longer than 1.25 mi are rare in the study area. Drumlins in the northern part of the study area are principally composed of lodgment till, with a cap of loose ablation till of variable thickness. Drumlins in the northern part of the study area occur in clusters, in which two or three drumlins are often separated from other clusters by minor meltwater drainage channels. In the southern part of the study area, the drumlins tend to occur singly. Davis (1941) analyzed the length-to-width ratios of drumlins in the Macedon, Palmyra, and Newark quadrangles northward to the Lake Ontario shoreline. Her analysis shows that drumlins nearer the lakeshore have length-to-width ratios of 2:1 to 3:1, with ratios gradually increasing to 5:1 as one moves southward, such that the drumlins became progressively narrower and longer the farther south they are located. This change in shape and size is attributed to a change in the underlying bedrock, with the longer and narrower drumlins being underlain by more easily erodible Camillus and Vernon Shales in the south, whereas the shorter drumlins to the north are underlain by more resistant shales and some carbonates. The clay content of the till that overlies bedrock, and thus the clay content of the resulting drumlins, increases from north to south with the progression from the Williamson Shale, Irondequoit Limestone, and Lockport Dolomite in the north, into the more easily erodible Vernon and Camillus Shales of the Salina Group to the south.

Many of the drumlins within the study area were modified by wave erosion during the Lake Dana stage, as they were undoubtedly partly submerged during this time, and later by glacial meltwater streaming off the receding ice front, once it had retreated northward toward Lake Ontario. Davis (1941) has documented wave-cut terraces in many of the drumlins that were located within the area covered by glacial Lake Dana. Between the Lake Dana and Lake Dawson stages, meltwater flowed through the north-south channels between the drumlins in the area north of the Fairport-Lyons channel, partly eroding them. The eroded and reworked drumlin sediments—chiefly gravel, sand, silt, and clay—were redeposited in the flat areas between the drumlins. This meltwater drainage was of short duration and not associated with any widespread glacial lake in the Fairport-Lyons channel (Davis, 1941).

Drumlins in the southern part of the study area were termed “rocdrumlins” (drumlins with a bedrock core) by Davis (1941); however, logs of domestic wells drilled through drumlins in the study area consistently show a core of till, underlain in some places by layers of fine sand or gravel resting on bedrock that, at several sites, is several ft higher than that penetrated by nearby wells in inter-drumlin areas. Section *E–E′* shows a longitudinal section through a drumlin and adjacent esker located northeast of Lyons (plate 2). This section clearly shows till thicknesses of as much as 90 ft that overlie a relatively flat bedrock surface. Interposed between the till and bedrock is a layer of fine sand that may represent older lacustrine deposits. Adjacent to the drumlin is an esker composed of ice-contact sand and gravel, which is more than 50 ft thick in places.

Ice-Contact Deposits

Ice-contact stratified deposits consist of sand, gravel, silt, and clay that were deposited by meltwater streams issuing from the receding ice front, in contact with glacial ice. Examples of ice-contact stratified deposits include such forms as kame deltas, eskers, and kames.

Kame Deltas

Fairchild (1907) mapped several small kame deltas within the study area. Small kame deltas are located along the Fairport-Lyons channel, and a fairly large kame delta is at the eastern terminus of the channel at Lyons. Several kame deltas are southwest of Macedon, along the southern edge of Ganargua Creek valley west of Palmyra, and along the southern edge of the Erie Canal at Port Gibson. One is in the Ganargua Creek valley northwest of Lyons, a large delta is at Lyons, and another large delta is at the eastern terminus of the Fairport-Lyons channel where it enters the Clyde River valley, southeast of Lyons. These kame deltas were produced by meltwater streams issuing from the receding ice front and depositing their sediment loads into a short-lived glacial lake that occupied the Fairport-Lyons channel as far west as Palmyra. This lake was an arm of Lake Iroquois, which was located to the east, and was evidently short lived. The large delta at the eastern terminus of the Fairport-Lyons channel, just to the southeast of Lyons, is the result of sediment loads also being deposited into glacial Lake Iroquois. Today, these deltas are mostly at elevations above the present-day stream elevations, so they remain largely unsaturated (Griswold, 1951).

Eskers and Kames

Eskers are long, sinuous ridges mostly composed of coarse, stratified sand and gravel that were deposited by fast-moving meltwater streams in crevasses and tunnels within or beneath stagnant ice, and which generally overlie till or bedrock. Davis (1941) mapped several eskers within the present study area, with heights between 10 and 30 ft and lengths of as much as 0.75 mi. In this study, numerous eskers and esker-form ice-contact deposits were identified through the use of lidar data in conjunction with SSURGO data (U.S. Department of Agriculture, 2008) and are shown on plate 1. Of particular note are two north-south lines of eskers and esker-form ice-contact material, each about 10 mi long, that pass through Palmyra and Newark, respectively (plate 1).

Kames are small, rounded hills composed of stratified sand, silt, clay, and gravel that were deposited by glacial meltwater atop thin or discontinuous stagnant ice near the glacier's margin and acquired their hummocky topographic form as underlying ice melted. Davis (1941) reports that the kames in the present study area are almost entirely composed of fine, well-sorted, stratified sand, with little or no coarse material in them, which implies that they were deposited in standing water, perhaps shallow ponded water against stagnant glacial ice. In some kames, there are alternating layers of fine sand and crudely stratified gravel, which are the result of seasonal variations in streamflow during the depositional period. Davis (1941) mapped a belt of kames about a mile wide that extends from about 4 mi due south of Palmyra, northward to about 7 mi north of Palmyra, and includes eskers and esker-form deposits (plate 1). These kames are not individually more than 20 to 30 ft high, and when they are in a group, they form a slightly undulating topography. The kames in this belt are composed chiefly of sand. Another group of kames, located about 2 mi southeast of Port Gibson, form a group of low hills within a valley bottom along the east side of adjacent drumlins (Davis, 1941).

Lacustrine Sediments

Lacustrine sediments are primarily fine sand, silt, and clay deposited into proglacial lakes by glacial meltwater streams. Surficial lacustrine sand, silt, and clay occur primarily in areas that were covered by glacial Lake Iroquois, including an arm of Lake Iroquois that occupied the Fairport-Lyons channel as far west as Palmyra. Logs of wells in the Fairport-Lyons channel show as much as 40 ft of lacustrine fine sand, silt, and clay that, in places, overlie previously deposited sand and gravel. In the Clyde River valley east of Lyons, lacustrine fine sand, silt, and clay overlie weathered shales of the Salina Formation, such that the lacustrine sediments are not easily distinguished from the underlying clays that were produced by the weathering of the shale bedrock.

Glaciofluvial Deposits

Glaciofluvial deposits include sand and gravel derived from previously deposited kame deltas which were deposited in some areas of the Fairport-Lyons channel by water draining through the channel from glacial Lake Dawson, west of Fairport, and emptying into glacial Lake Iroquois east of Lyons. These surficial sand and gravel deposits overlie previously deposited till or lacustrine silt and clay and typically contain minor interbedded layers of silt and clay derived from reworked till being periodically washed into the channel from meltwater coursing southward through the drumlin field to the north. These sand and gravel deposits, where they are located below the level of the Erie Canal, form very transmissive aquifers that can sustain large pumping rates. The largest deposits are located at Macedon, Newark, and Lyons and near Clyde, N.Y., where several wellfields have been established.

Aquifers Within the Fairport-Lyons Channel System and Adjacent Areas

Groundwater supply has historically been obtained from a variety of sources within the study area as described in figure 3, but public and industrial supply has largely been limited to (1) unconfined aquifers in glaciofluvial deposits associated with large areas in and along the largest channels or where those channels discharged into standing water bodies, and (2) confined channel aquifers of glaciofluvial or ice-contact deposits located beneath fine-grained lacustrine deposits. Potentially favorable and proven aquifer areas within these deposits are outlined on plate 1. Local domestic wells tap a greater variety of deposits with modest water yields. Historically, dug wells tapped gravelly zones within till, thinly saturated unconfined ice-contact deposits, or shallow jointed bedrock in addition to the more productive sources mentioned previously. In areas located some distance from permeable channel deposits, most present-day domestic wells are completed in bedrock. A few domestic wells are completed in confined sand and gravel deposits immediately above bedrock and beneath glacial till within and between drumlins; such wells are highlighted in yellow on plate 1, and the deposits are depicted in hydrogeologic sections *C–C′* and *E–E′* on plate 2 and in figure 3.

The Fairport-Lyons channel system was identified as a potential source of large groundwater supplies in Wayne County by Griswold (1951). However, a subsequent study by Crain (1974) which involved a reexamination of available well logs and logs of additional test borings drilled in 1966, established that unconsolidated sediments in the channel are generally thin, such that bedrock is within a few feet of land surface. However, the deposits of sand and gravel are generally thick enough to support substantial groundwater withdrawals in three places: at Lyons, at Newark, and in small areas east of Macedon (plate 1). Evidence from previously published reports and logs of wells and test borings indicate that there is not one single sand and gravel aquifer that occupies the intersecting incised channels that extend for 26 mi from Fairport, through Lyons, to the broad lowland near Clyde. Rather, sand and gravel deposited by southward-flowing meltwater streams, inferred to have flowed largely during the Lake Dawson drainage episode, are interbedded with fine-grained lacustrine silt and clay and can be regarded as separate aquifer units within the Fairport-Lyons channel system. In some areas, notably at Macedon, a surficial sand and gravel aquifer overlies till and lacustrine deposits. Elsewhere, notably northeast of Lyons, a large sand delta produced by Lake Dawson water debouching into the Clyde River valley (Fairchild, 1909) provides

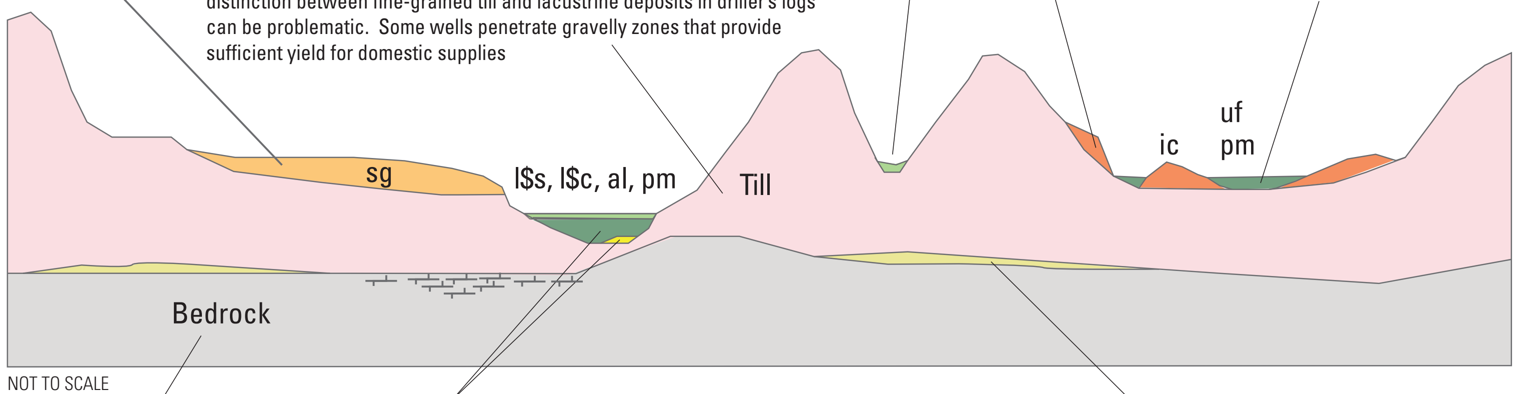
Glaciofluvial sand and gravel deposits—Deposited by meltwater discharge from ice to the north that initially flowed southward across multiple saddles between drumlins just beyond the southern margin of the study area, but later flowed southward and eastward into early stages of proglacial Lake Iroquois. The outwash was deposited chiefly in the form of terraces, which were as much as 60 feet thick and were subsequently deeply incised by the Fairport-Lyons channel; most villages were built on these terraces. Water-resource potential from the outwash sand and gravel is greatest where terraces are areally extensive and have not been incised down to the underlying till or bedrock, such that withdrawals from wells can induce recharge from streams or the barge canal. Large-diameter municipal wells in such localities have reported yields of a few hundred gallons per minute. Outwash terraces distant from the Fairport-Lyons Channel are relatively thin, and thus have limited water-resource potential

Small areas of meltwater channel fill between drumlins—Either thin sand and gravel, sand, or fine-grained lacustrine deposits. Little water-resource potential

Ice-contact deposits—Sand, gravel, and silt with highly variable sorting. Deposited beneath, within, or adjacent to glacial ice. Often in the form of hummocky terrain in poorly drained areas that were not inundated or eroded by meltwater flows. Most common in several north-south subglacial drainage ways that in some instances cut across dissected drumlins, and along an east-west belt (an inferred ice margin) in the southern part of the study area. Water-resource potential is limited by thin saturated thickness and the local extent of deposits

Glacial Till—Unsorted sediment deposited by glacial ice chiefly in the form of drumlins. Till in this region is mostly fine grained because the ice overrode and incorporated existing lacustrine deposits as it advanced. The distinction between fine-grained till and lacustrine deposits in driller's logs can be problematic. Some wells penetrate gravelly zones that provide sufficient yield for domestic supplies

Peat-muck or undifferentiated fine-grained deposits—Infill in low areas among ice-contact deposits or till. Fine-grained deposits may include lacustrine fine sand, silt, and clay as well as alluvium. Poorly permeable



Fairport-Lyons channel fill—Surficial deposits in the channels range from alluvium, peat-muck, and fine lacustrine deposits to thin till over bedrock and cut-and-fill areas associated with the Erie Canal. Beneath the floor of the Fairport-Lyons channels, some borehole logs describe mostly fine lacustrine sand, silt, and clay; others report poorly sorted gravels interlayered with lacustrine fines. If these channels were initially incised during an earlier deglaciation, fine-grained till deposited therein during the last glacial advance may be present but misidentified as lacustrine deposits; if these channels were incised entirely during the latest deglaciation, these fines must have been deposited into an arm of Lake Iroquois after incision. Basal gravel that is tapped for water supply at Lyons may have been deposited during incision where channel width increased and water velocity slowed

Confined fine sand or sand and gravel of unknown origin beneath till—Locally used for domestic water supply. Discontinuous; distribution across study area largely undefined

Bedrock—Predominantly shale and carbonate sedimentary rocks underlie the study area. Evaporite deposits (gypsum, rock salt) are associated with some shales. Where evaporites are present, wells that penetrate them typically have unpotable water with high concentrations of dissolved solids. In places, the evaporites have been leached from the upper few tens of feet in the shale, leaving a highly permeable rock rubble that can provide yields in excess of that needed for domestic supply

Figure 3. Generalized geologic section showing the occurrence of sediment types and their relative potential as a groundwater resource in the study area. al, alluvium; ic, ice-contact deposits; l$c, lascustrine silt and clay deposits; l$s, lacustrine silt and sand deposits; pm, peat-muck; sg, sand and gravel deposits; uf, undifferentiated fine-grained deposits.

groundwater to many individual residences (plate 1; plate 2, section *F–F′*). The subsidiary east-west drainage channels that are tributaries to the main Fairport-Lyon channel, such as those northeast of Macedon, between Palmyra and Newark, northeast of Newark, and northeast of Lyons, are predominantly filled with fine-grained lacustrine sediments that overlie till and bedrock. As such, these minor channels are mostly devoid of appreciable sand and gravel aquifers, except what are probably localized, stratified ice-contact deposits.

Griswold (1951) reported that sand and gravel deposits furnish the only large supplies of groundwater that are satisfactory for general use in Wayne County, and that the average depth of 82 wells that were completed in these deposits was 46 ft, with an average yield of 103 gal/min. The highest reported well yield of any well completed in the Fairport-Lyons channel is 1,200 gal/min from well WN-118, located at Newark (Crain, 1974). This well is 50 ft deep, with a 15-inch (in.)-diameter casing, and was completed with a gravel-packed well screen. Induced infiltration from the Erie Canal is probably responsible for the high well yield. Figure 3 shows the generalized occurrence of these sediment types in cross section and their relative potential as groundwater resources in the study area. A more detailed discussion of the distribution and character of these separate sand and gravel aquifers, by specific area, follows.

Macedon Area

Cushman (1946) investigated the groundwater resources of the Macedon area, including the occurrence of significant sand and gravel within the Fairport-Lyons channel. He reported that test borings along the centerline of the Erie Canal at Lock 30 show an average thickness of glaciofluvial gravel of about 23 ft. However, test borings and well records indicate that the unconsolidated material in the Fairport-Lyons channel here consists of an upper bed of fine, silty clay with intercalated lenses of sand and gravel, underlain by blue clay and till (which drillers often refer to as “hardpan”). These lenses of sand and gravel are typical of the available sources of groundwater supply in the Macedon area. The Macedon production well (WN-173) is a 10-foot-diameter dug well that is 20 ft deep and draws water from gravel lenses with a maximum yield of 175 gal/min. Nine test holes drilled within a radius of 1,000 ft of WN-173 do not indicate a continuous sand and gravel zone; rather, the sand and gravel are distributed as lenses at different depths (Cushman, 1946).

Nine borings along the centerline of the Erie Canal from Wayneport to about 3 mi east of Macedon all show mostly clay, fine sand, muck, and hardpan (till). Only two of these borings show any appreciable sand and gravel, and they are located at the confluence of Ganargua Creek with the Fairport-Lyons channel (Cushman, 1946). This sand and gravel may be evidence that the ancestral Ganargua Creek channel was a source of additional sand and gravel, deposited into the Fairport-Lyons channel after it was filled with sediment from the draining of glacial Lake Dawson. Well WN-520 is a 26-foot-deep, 12-in.-diameter production well that yields 275 gal/min; however, its yield is reported to decline during the winter (Crain, 1974). This well and others (WN-173, WN-1050) at Macedon are completed in thin sand and gravel outwash below the elevation of water surface in the Erie Canal, which is about a half-mile to the north (section *A–A′*).

Groundwater pumped by production wells near Macedon is probably enhanced by induced infiltration from the Erie Canal. During the summer navigation season, the level in the Erie Canal is raised to allow for a mean depth of 12 to 14 ft to accommodate vessel traffic. During this high-water season, enough induced infiltration occurs to sustain the maximum pumping rates in the Macedon wellfield. During the winter non-navigation season, the level in the Erie Canal is lowered by an average of 10 ft, which reduces the head difference between the Erie Canal stage and the water table at each well, thereby reducing the gradient and thus the groundwater flow to each well. Moreover, the viscosity of the canal water increases during the winter, which has the effect of further decreasing induced infiltration and the transmissivity of the thinly saturated sand and gravel aquifer there. A similar situation has been documented at the Schenectady, N.Y., wellfield by Winslow and others (1965). Section *A–A′* (plate 2) though the Macedon wellfield shows the stratigraphy of the unconsolidated sediments in this area, and the surficial sand and gravel is at least 54 ft thick near well WN-1050, with a saturated thickness of about 45 ft. Well WN-1050 was completed as an open-ended well (no screen) and was pump tested at 100 gal/min. A well at this location could presumably withdraw groundwater from aquifer storage during winter periods when the yield of WN-520 is limited. The log of test well WN-225 and nearby borings indicate that the sand and gravel aquifer just east of Macedon is about 40 ft thick and, more importantly, extends below the level of the nearby Erie Canal (Reynolds and others, 2022). Well WN-225 was pumped at 337 gal/min, indicating a fairly high transmissivity in this locality.

Palmyra Area

A large deposit of silty sand and gravel underlies Palmyra and, prior to the incision of the Fairport-Lyons channel, was probably contiguous with sand and gravel along Red Creek valley to the north. Test borings within the Fairport-Lyons channel (WN-610, WN-611) indicate that the upper 15 to 30 ft consists of gravelly medium to fine sand, with varying amounts of silt, clay, organic material, and shell fragments (presumably postglacial alluvium), all of which overlies dense clayey silt down to bedrock. Within the Fairport-Lyons channel, the log of boring WN-611 indicates a total sediment thickness of about 81 ft (Reynolds and others, 2022), being slightly deeper to the south in the center of the channel. The clayey silt was probably deposited in the arm of glacial Lake Iroquois that extended into the Fairport-Lyons channel (Fairchild, 1909) and may extend beneath the broad 480-ft-elevation deltaic terraces south of the channel. The log of

WN-1102, which penetrates the terrace, shows only 15 ft of clayey sand and gravel underlain by about 50 ft of lacustrine clay (Reynolds and others, 2022). These terraces represent deltas that progressed into the arm of glacial Lake Iroquois from meltwater coursing southward from Red Creek. The aquifer here is composed of the upper 30 ft of variously silty and sandy gravel, which is moderately permeable. A generalized depiction of stratigraphy of the sediments in the Palmyra area is provided by Section *B–B′* (plate 2).

Newark Area

A productive surficial sand and gravel aquifer, about 1.5 mi in length, underlies the northern part of Newark. Records of wells WN-208, WN-527, WN-46, and WN-118 document 38 to 48 ft of surficial gravel, the lower 10 to 34 ft of which is saturated. A terrace remnant at the same elevation, near well WN-131 to the northwest, was probably continuous with this aquifer prior to the incision of the Fairport-Lyons channel. Yields from most wells completed in this surficial aquifer are limited to recharge from precipitation. Near well WN-118, however, the surficial aquifer extends beneath the Erie Canal, which means that groundwater withdrawals at this location can be sustained by induced infiltration (Crain, 1974). Well WN-118 is 48 ft deep and is equipped with a 20-ft-long gravel-packed screen that enables daily pumpage rates to exceed 1 million gallons per day (Mgal/d; Crain, 1974). Wells WN-208 and WN-244 were drilled through 60 ft of clay into a deep gravel aquifer and reportedly overflow at land surface. This deep aquifer may be a segment of the line of ice-contact deposits mapped directly to the north and south of Newark (plate 1). Information about the quality of water from these wells was not obtained during this study; however, confined valley-fill gravel aquifers in valleys are generally recharged by water from the underlying bedrock, which, in this area, is likely to be salty.

Two production wells near Newark, WN-244 and WN-527, are also completed in the Fairport-Lyons channel. WN-244 is an 8-in.-diameter well that is 100 ft deep and produces 100 gal/min. WN-527 is a 38-ft-deep well that produces 300 gal/min and is equipped with a turbine pump. Crain (1974) reports that another area that may be favorable for groundwater development in the Newark area is near the confluence of the Ganargua Creek valley and the Fairport-Lyons channel, near WN-172.

Section *C–C′* (plate 2) shows the stratigraphy of the unconsolidated sediments in the Newark area. The section traverses the Ganargua Creek valley in a north-south direction, then bends southeasterly through Newark. Section *C–C′* shows that the Ganargua Creek valley contains mostly fine-grained lacustrine sediments that overlie till and bedrock. The section also shows that the large alluvial terrace that underlies Newark on both sides of the Erie Canal consists mostly of sand and gravel that overlie a thick section of till, which overlies bedrock.

Lyons Area

The principal sand and gravel aquifer in the Lyons area is located below the level of the Erie Canal; however, the hydraulic connection with the canal varies from place to place because of the presence of discontinuous, interbedded, silt and clay confining units. There is a wellfield in the Fairport-Lyons channel near wells WN-102, WN-101, and WN-554. Well WN-605, nearby, has a reported test yield of 1,000 gal/min with a specific capacity of 55 gallons per minute per foot (gal/min)/ft (Crain, 1974).

Well WN-554 was originally drilled to a depth of 97 ft and was completed in shales of the Salina Formation, but it produced saline water. The well was then grouted up to the 67-foot depth, at the top of bedrock, and the casing was perforated from 52 to 62 ft, opposite a gravel zone that overlies bedrock. It has a reported yield of 600 gal/min and has been used as a production well (Griswold, 1951). An aquifer test conducted on this well in 1950 resulted in a transmissivity estimate of 115,000 ft squared per day (ft^2/d) for an aquifer thickness of 10 ft, which results in a very high hydraulic conductivity of 11,500 feet per day (Griswold, 1951). Crain (1974) estimated that as much as 4 Mgal/d could be withdrawn from this small aquifer because of the degree of hydraulic connection with the Erie Canal, if a stable water level were maintained in the canal. Section *D–D′* (plate 2) through the Lyons wellfield shows the stratigraphy of the stratified drift in this area. At this location, there is an upper surficial aquifer of sand and gravel that is about 20 ft thick and a basal, confined sand and gravel aquifer that is 10–15 ft thick. Separating the two sand and gravel aquifers is a semiconfining unit of lacustrine fine sand, silt, and clay of variable thickness. All of the freshwater production wells in the wellfield near Lyons are completed in the lower confined sand and gravel aquifer. Production well WN-789, drilled in 2003, has a 16-in.-diameter casing, is 60.9 ft deep, and is equipped with a 12-in. by 10-ft-long stainless-steel gravel-packed screen with a 0.1-in. slot size. The well is equipped with a submersible pump, has been tested at 600 gal/min, and can produce 425 gal/min as designed.

Section *E–E′* (plate 2) shows a longitudinal section though a drumlin and adjacent esker located northeast of Lyons. The esker likely has a thin saturated thickness. Farther northeast of Lyons is a broad valley floor containing a few drumlins underlain by an outwash delta that was either produced by meltwater draining from the receding ice front to the north, or from Lake Dawson stage water coursing through the Fairport-Lyons channel and debouching into the Clyde River valley, just east of Lyons. This outwash delta has produced a sand and gravel aquifer in the western part of section *F–F′* that is as much as 70 ft thick in places. The Village of Clyde has drilled numerous test wells and now has several production wells completed in this aquifer, all of which are about 60 ft deep. Well WN-723 is a 10-in.-diameter production well that is screened from 53 to 60 ft and which produces 450 gal/min from a 72-ft-thick section of this unconfined aquifer. Another well in this wellfield, WN-807, is 18 inches in diameter, 55 ft deep, screened from 45 to 55 ft, and produces 315 gal/min.

At Fergusons Corners, just to the west of the Clyde wellfield, two wells—WN-576 and WN-600—penetrate about 65 ft of sand and gravel. In the southeastern half of section *F–F′*, the unconsolidated sediments transition from sand and gravel to lacustrine silt and clay and then to lacustrine sand, which represents the distal part of the delta created by the deglacial meltwater. Farther southeast, near the Erie Canal, the surficial lacustrine sand unit thins to about 20 ft and overlies about 40 ft of sand and gravel at well WN-167. At the southeastern end of section *F–F′*, within the Fairport-Lyons channel, the sand and gravel aquifer is about 40 ft thick. In this area of the channel, two large-diameter supply wells in the channel, WN-338 and WN-242, are both 22 ft deep and produce 318 and 280 gal/min, respectively, from this aquifer.

Areas South of the Fairport-Lyons Channel System

Near the southern edge of the study area (primarily in Ontario County) there is an east-west topographic divide that approximately coincides with the ice-margin position delineated on figure 2. South of the divide, meltwater from the retreating ice sheet deposited extensive, but generally thin, sand and gravel in temporary proglacial lakes that drained southward through saddles between drumlins and were graded to a large west-to-east channel south of the study area that is now partly occupied by Canandaigua Outlet (fig. 2). Much of this sand and gravel now underlies terrace surfaces at 580–595 ft in elevation. Eventually the ice sheet retreated far enough to allow meltwater to drain eastward and deposit deltas or glaciofluvial deposits at lower elevations closer to the present-day elevations of the Fairport-Lyons channel. No public supplies tap the sand and gravel deposits graded to the south, but scattered shallow domestic wells tap apparently thinly saturated sand and gravel in places. The greatest aquifer potential within the Ontario County part of the study area is likely in the southwestern corner within the broad, flat outwash terrace (or delta) at Farmington (fig. 1; plate 1), which is incised by Ganargua Creek on the west side. This terrace has a surface elevation of 550–560 ft, which requires deposition by discharge of lake water from the west through a channel south of Victor, N.Y. This terrace is bordered south of Farmington by small, higher terraces deposited by southward meltwater flow prior to the drainage diversion.

Bedrock Aquifer

In the study area, the Fairport-Lyons channel system is underlain by shales of the Salina Group and the Lockport Dolomite. Two shale units of the Salina Group—the Camillus Shale and the underlying Vernon Shale (of Clarke, 1903)—underlie the middle and southern parts of the study area. The Lockport Dolomite, a hard rock composed largely of magnesium carbonate, underlies the northernmost part of the study area (Davis, 1941). Gillette (1940) reports that the Vernon and Camillus Shales are similar in physical properties and color, and that both are soft, structurally weak rocks that are composed of gray, green, and red shales. The Camillus and Vernon Shales contain extensive beds of gypsum and salt, both of which are very soluble in water. Crain (1974) suggests that all of the salt and much of the gypsum have been dissolved out of the Camillus and Vernon Shales in their respective outcrop areas and for some distance south of the outcrop areas. This removal of soluble salt and gypsum results in large solution cavities in the shales; however, shales are structurally weak, so collapse of shale overlying these cavities is common, which results in partial filling of the cavities but also causes additional fracturing of the shales (Crain, 1974). The additional fracturing and dissolution of salt and gypsum layers result in fairly high well yields for domestic wells completed in these two shale units. Griswold (1951) reported that the average yield of 101 wells in Wayne County that were completed in the Camillus and Vernon Shales was 31 gal/min, with the highest reported yield being 400 gal/min for a commercial well (WN-11). The average depth of the wells inventoried in the Camillus and Vernon Shales was 100 ft.

The dissolution of these salt and gypsum beds within the Vernon and Camillus Shales has resulted in a high dissolved mineral content of groundwater from these two rock units, which makes the water quality unsatisfactory for use as drinking water in most places. Goodman and others (2011) report that while salt beds of the Salina Group are preserved south of the Onondaga Escarpment, upper units of the Salina Group, such as the Camillus and Vernon Shales, have been thoroughly leached by post-Pleistocene and modern-day actively circulating groundwater. Undesirable amounts of hydrogen sulfide, salt, and iron are present in varying amounts in groundwater from the Vernon and Camillus Shales. Wells deeper than 100 ft generally intersect layers of salt, which produce water with high chloride content (brine), and layers of gypsum (calcium sulfate), which are responsible for high noncarbonate hardness levels. For example, well WN-546 is a 371-ft-deep, 8-in.-diameter production brine well for Lyons, which has a yield of 600 gal/min. The well is completed in shale beds of the Salina Formation and produces water with a chloride level of as much as 21,000 milligrams per liter. In contrast, most bedrock wells that produce satisfactory water for drinking penetrate less than 30 ft of bedrock (Griswold, 1951). Driller's logs of some wells and test borings that penetrate the Camillus and Vernon Shales report that the upper surface of the rock has weathered to clay, to a depth of as much as 10 ft, and that it is difficult to distinguish the weathered shale from any overlying lacustrine silt and clay units. This condition is illustrated in sections *D–D′* and *E–E′* on plate 2.

Summary

The most productive zone of aquifers within the study area is associated with the Fairport-Lyons glacial-stream channel in Wayne County, New York, and adjacent areas (hereinafter referred to as the "Fairport-Lyons channel"). The Fairport-Lyons channel is a west-east-oriented bedrock channel in southern Wayne County that once served as the outlet for a proglacial lake. The Fairport-Lyons channel and intersecting subsidiary channels are hereinafter referred to as the "Fairport-Lyons channel system." Glacial meltwater eroded this shallow channel network into the underlying bedrock, and the channels subsequently filled with interlayered glaciofluvial sand and gravel and fine-grained lacustrine deposits.

Sand and gravel aquifers in the Fairport-Lyons channel system are one of the few sources of large supplies of groundwater suitable for general use in Wayne County. A reexamination of well logs available in U.S. Geological Survey files, recent well logs from the New York State Department of Environmental Conservation's Water Well Permit database, and logs of test borings has established that, in many places, the channels are generally shallow and that depth to bedrock usually ranges between 20 and 80 feet below land surface. However, saturated thicknesses of sand and gravel beneath terraces adjacent to the channels or beneath the flood plain are locally thick enough to support substantial groundwater withdrawals from properly constructed wells, as indicated by current (as of 2018) and past groundwater supplies at Macedon, Newark, Lyons, and Palmyra, N.Y. Areas with potential for groundwater supplies, both in and out of the channels proper, have been outlined on a surficial geologic map. Evidence from previously published reports and logs of wells and test borings indicate that there is no one single sand and gravel aquifer that occupies the 26 miles of the Fairport-Lyons channel. Rather, a gravel aquifer, approximately 40 feet thick, immediately underlies the flood plain just east of Macedon; an aquifer occurs in the basal saturated part of the terrace bordering the flood plain at Newark; and a gravel aquifer underlies lacustrine silt and sand atop bedrock at Lyons. Northeast of Lyons, a large sand delta produced by Lake Dawson water debouching into the Clyde River valley provides groundwater to Clyde, N.Y., and to many individual residences. High well yields, as much as 1,200 gallons per minute, have been reported for supply wells screened in sand and gravel deposits within the Fairport-Lyons channel that have a good hydraulic connection to the Erie Canal, indicating a reliance on induced infiltration of surface water for such high sustained yields.

Logs of domestic wells show that sand or sand and gravel are present in places beneath the till that composes the drumlin field. This groundwater source has not been previously documented in this area; however, its thickness and spotty occurrence indicate that it could be a possible source for domestic supply.

In the study area, the Fairport-Lyons channel system is underlain by shales of the Salina Group and the Lockport Dolomite. Two shale units of the Salina Formation—the Camillus Shale and the Vernon Shale—underlie the middle and southern parts of the study area, while the Lockport Dolomite underlies the northernmost part of the study area. The Vernon and Camillus Shales are soft, structurally weak rocks that contain extensive beds of gypsum and salt, both of which are soluble in water. The removal of soluble salt and gypsum results in large solution cavities in the shales. Because shales are structurally weak, collapse of the shale that overlies the solution cavities is common, resulting in partial filling of the cavities and causing additional fracturing of the shales. This additional fracturing and dissolution of salt and gypsum layers results in fairly high well yields for domestic wells completed in these two shale units; however, the dissolution of the salt and gypsum beds results in groundwater from these two rock units having a high mineral content that is unsatisfactory for drinking water in most cases.

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For more information about this report, contact:
Director, New York Water Science Center
U.S. Geological Survey
425 Jordan Road
Troy, NY 12180–8349
dc_ny@usgs.gov
(518) 285–5602
or visit our website at
https://www.usgs.gov/centers/ny-water

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