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905020

SUPPORTING DOCUMENTS FOR ENGINEERING INVESTIGATIONS AT INACTIVE HAZARDOUS WASTE SITES

Michael Wolfer Site No. 905020

Village of Delevan Cattaraugus County

Prepared for:

New York State Department of Environmental Conservation

50 Wolf Road, Albany, New York 12233

Thomas C. Jorling, *Commissioner*

Division of Hazardous Waste Remediation

Michael J. O'Toole, Jr., *Director*

By:

Rust Environment & Infrastructure of New York, Inc.

in association with

TAMS Consultants, Inc.

SUPPORTING DOCUMENTS FOR ENGINEERING INVESTIGATIONS AT INACTIVE HAZARDOUS WASTE SITES

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March 1993

TABLE OF CONTENTS

Chapter **Page**

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF TABLES

APPENDICES

SUPPORTING DOCUMENTS

SECTION 1

REFERENCES

List of References

A-1 Recra Environmental, Inc., Preliminary Site Characterization, Michael Wolfer, NYSDEC No. 905020, November 1987.

A-2 Federal Emergency Management Agency (FEMA), Flood Insurance Rate Map, Town of Machias, New York, Cattaraugus County, Community Panel Number 360084-0010B, August 20, 1982.

A-3 Broughton, J.G., Fisher, D.W., Isachsen, Y.W. Rickard, L.V., Geology of New York State - A Short Account, Educational Leaflet 20. The University of the State of New York/The State Education Department, NYS Museum and Science Service, Albany, New York, 1976.

A-4 Frimpter, M.H., Groundwater Resources, Allegheny River Basin and Part of the Lake Erie Basin, New York, New York State Department of Environmental Conservation, Albany, New York, 1974.

A-5 Cadwell, D.H., Surficial Geologic Map of New York - Niagara Sheet, 1988.

A-6 Pearson, C.S., J.C. Bryant, and W. Secor, Soil Survey Cattaraugus County, New York, USDA Bureau of Plant Industry, Cornell University Agricultural Experiment Station, Ithaca, New York, 1940.

A-7 Rickard and Fisher, Geologic Map of New York - Niagara Sheet, 1970.

A-8 Lenz and Riecker, State of New York Official Compilation of Codes, Rules and Regulations, Title 6 NYCRR Conservation, published for the Department of State, 1967.

A-9 Ecology and Environment Engineering, P.C., Phase I Investigation, Michael Wolfer, Site Number 905020, Village of Delevan, Cattaraugus County, February 1990.

A-10 Background Soil Elemental Concentrations (a compilation from cited literature).

Reference A-1

Recra Environmental, Inc., Preliminary Site Characterization, Michael Wolfer, NYSDEC No. 905020, November 1987.

RECRA ENVIRONMENTAL, INC.

Chemical Waste Analysis, Prevention and Control

3/6422

PRELIMINARY SITE CHARACTERIZATION

MICHAEL WOLFER
NYSDEC NO. 905020

DRAFT

Prepared For:

Motorola Inc.
1303 Algonquin Road
Schaumburg, IL 60196

Prepared By:

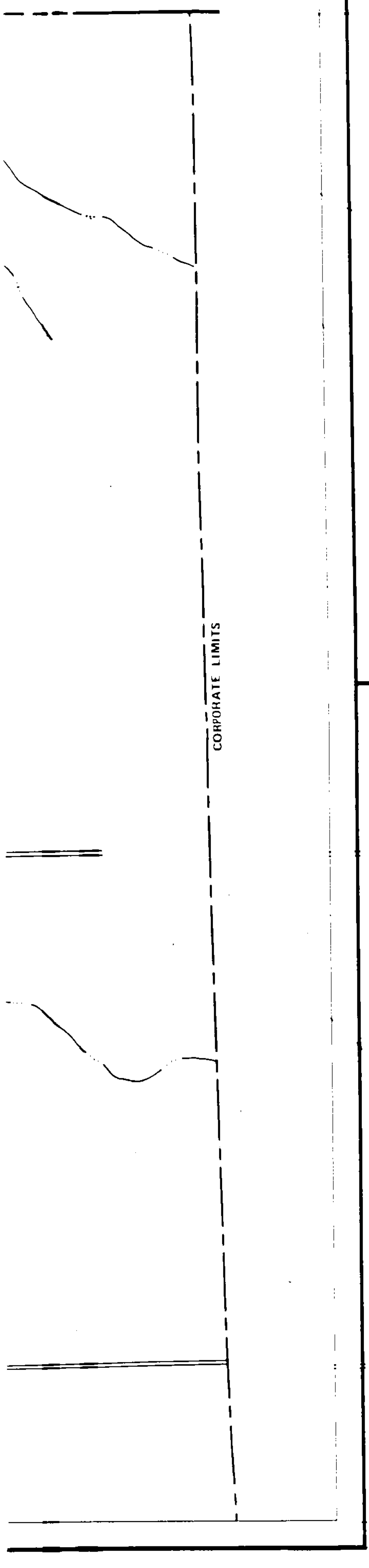
Recra Environmental, Inc.
Audubon Business Centre
10 Hazelwood Drive, Suite No. 106
Amherst, NY 14150

RECEIVED

November, 1987

Reference A-2

Federal Emergency Management Agency (FEMA),
Flood Insurance Rate Map, Town of Machias, New York, Cattaraugus County,
Community Panel Number 360084-0010B, August 20, 1982.



INITIAL IDENTIFICATION:
APRIL 11 1975
FLOOD HAZARD BOUNDARY MAP REVISIONS:
DECEMBER 16 1977

FLOOD INSURANCE RATE MAP EFFECTIVE:
MAY 25 1984
FLOOD INSURANCE RATE MAP REVISIONS:

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.

To determine if flood insurance is available in this community contact your insurance agent, or call the National Flood Insurance Program, at (800) 638-6620.

N

APPROXIMATE SCALE
800 0 800 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

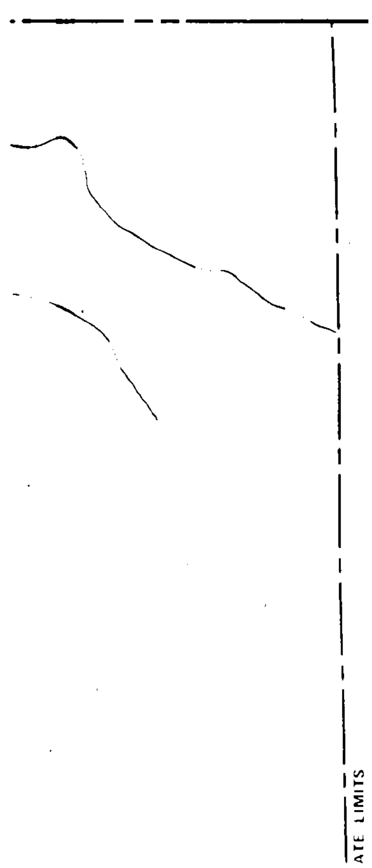
TOWN OF
YORKSHIRE, NEW YORK
CATTARAUGUS COUNTY

PANEL 2 OF 4
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
361104 0002 B

EFFECTIVE DATE:
MAY 25, 1984

Federal Emergency Management Agency



KEY TO MAP

Zone Designations*	ZONE C ZONE C
Base Flood Elevation Line With Elevation In Feet**	513
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7x
Zone D Boundary	
River Mile	•M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

A flood insurance map displays the zone designations for a community according to areas of designated flood hazards. The zone designations used by FEMA are:

ZONE	EXPLANATION
A	**Areas of 100-year flood; base flood elevations and flood hazard factors not determined.**
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C.	**Areas of minimal flooding. (No shading)**
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

INITIAL IDENTIFICATION:
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DECEMBER 16, 1977

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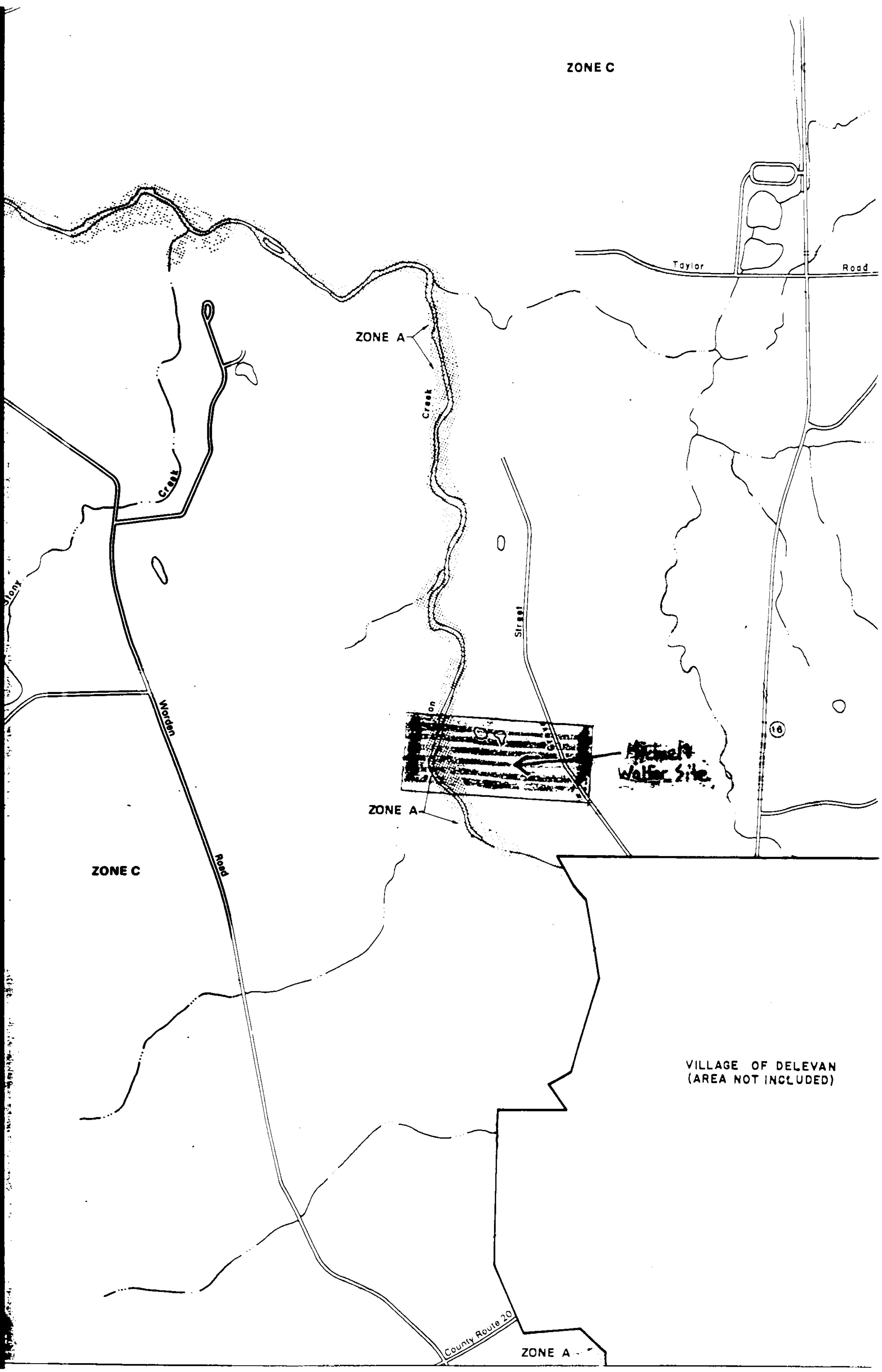
APPROXIMATE SCALE

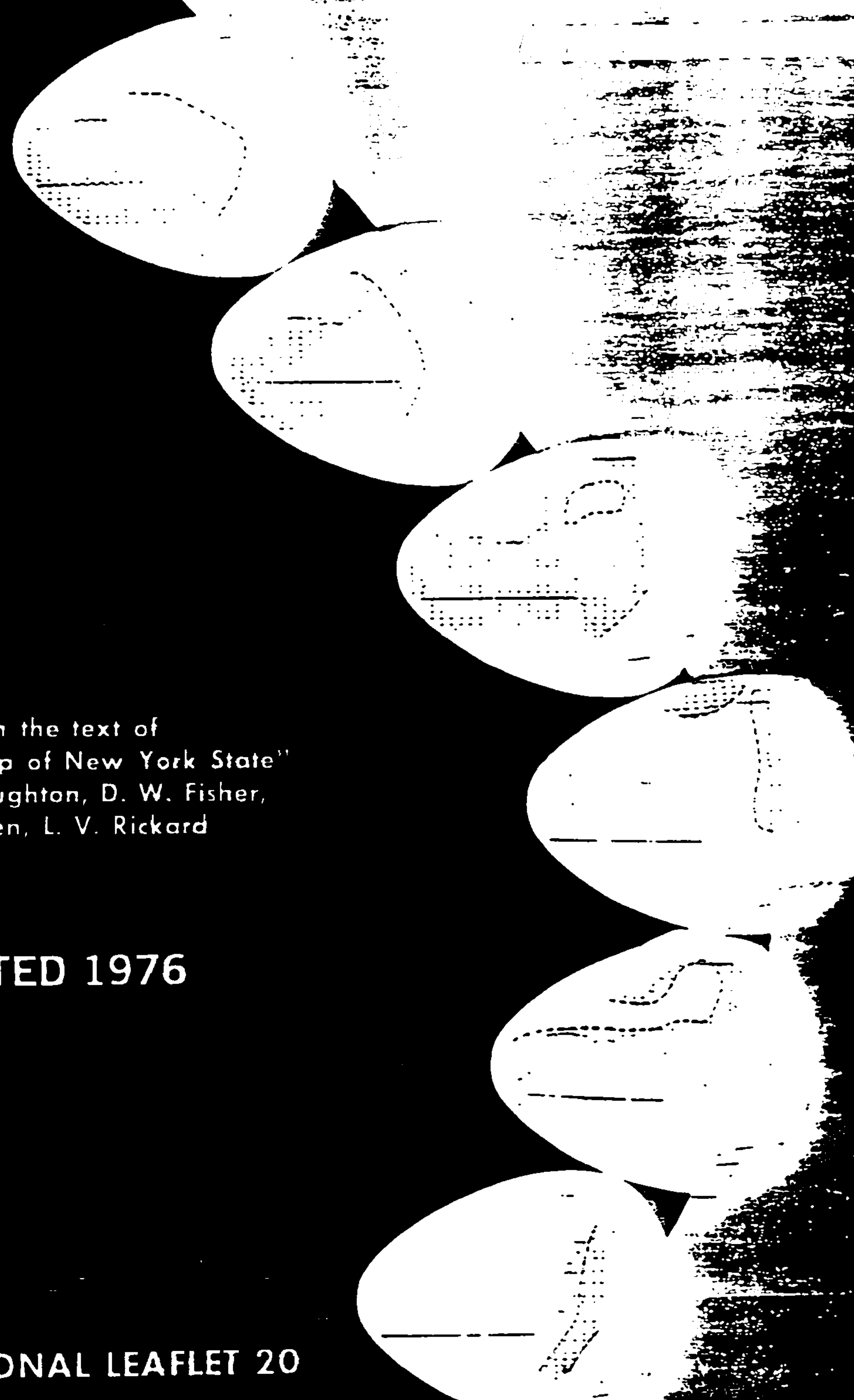
800 0 800 FEET


ZONE C
Taylor Road
ZONE A
Creek
Creek
Worden Road
Street
16
Mitchell Walter Site
ZONE A
ZONE C
VILLAGE OF DELEVAN
(AREA NOT INCLUDED)
County Route 20
ZONE A

Reference A-3

Broughton, J.G., Fisher, D.W., Isachsen, Y.W. Rickard, L.V.,
Geology of New York State - A Short Account, Educational Leaflet 20.
The University of the State of New York/The State Education Department,
NYS Museum and Science Service, Albany, New York, 1976.

Geolo



adapted from the text of
"Geologic Map of New York State"
by J. G. Broughton, D. W. Fisher,
Y. W. Isachsen, L. V. Rickard

REPRINTED 1976

EDUCATIONAL LEAFLET 20

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NEW YORK STATE MUSEUM AND SCIENCE SER... 1966

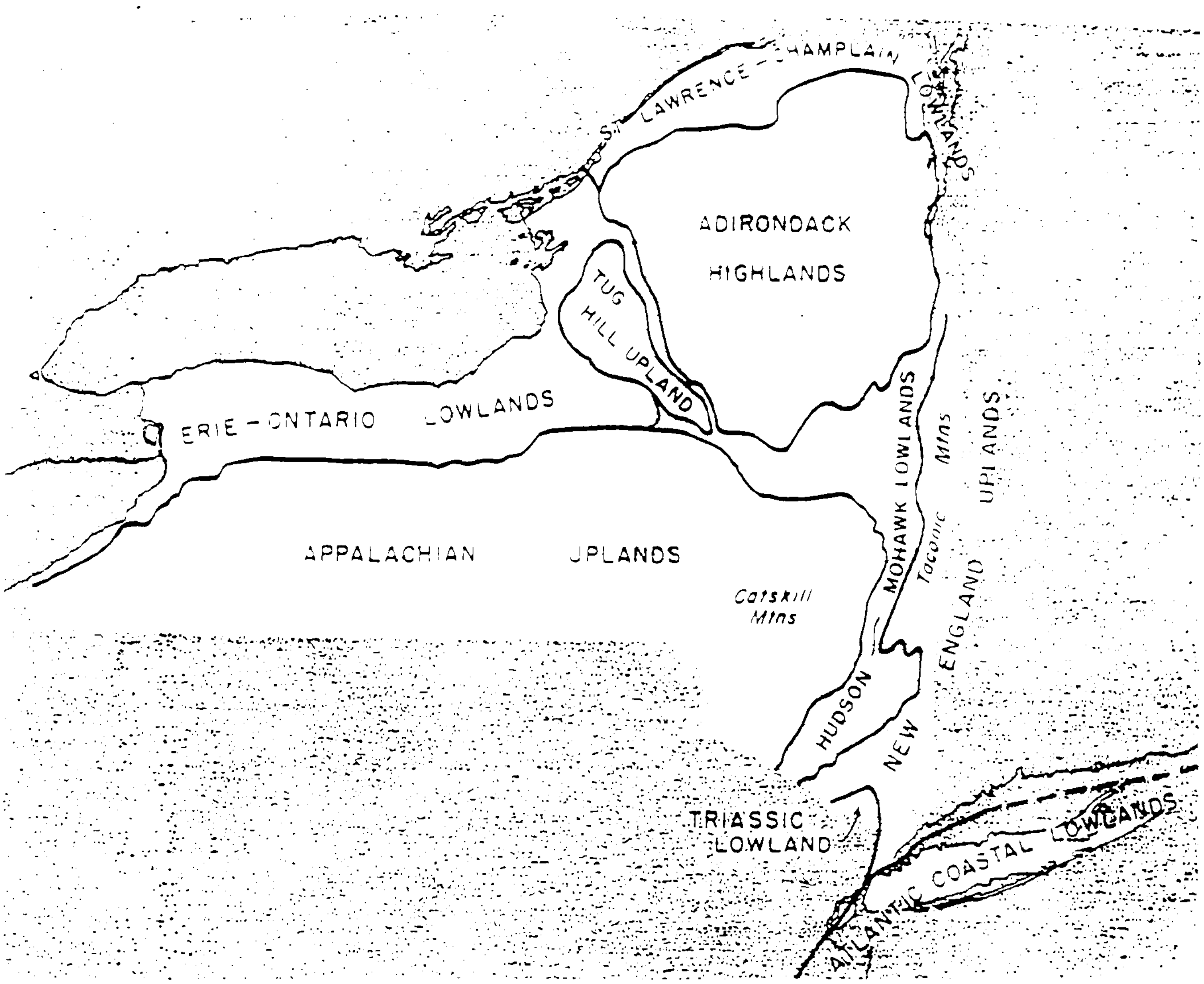


FIGURE 19. Physiographic provinces of New York, based on relief and geology (Modified after G. B. Cressey, 1952)

Cenozoic Era

PHYSIOGRAPHIC PROVINCES AND TERTIARY HISTORY

The physiographic provinces of New York are shown in figure 19. Modern landscapes of the State were shaped largely during the Cenozoic Era, the most recent 65 million years of geologic history. Although the overall features later would be modified and blurred by glaciation, the broad outlines of modern mountain, valley, and plain first were carved by the unrelenting rush of water to the earlier Cenozoic seas.

The long sequence of erosion presumably began with the arching of the Jurassic Fall Zone erosion surface in mid-Cretaceous time. As its eastern flank dipped beneath the encroaching Atlantic Ocean to receive Coastal Plain deposits, the axis domed sufficiently to initiate the sculpture of the Appalachians and Adirondacks. Few, if any of today's land forms can be traced so far back, however. Most researchers believe that all the exposed remnants of the dissected Fall Zone surface were obliterated by subsequent erosion.

South of New York, at least a partial record of Tertiary geology persists in the Coastal Plain deposits. In addition to a sedimentary record, datable igneous intrusions cut rocks of varying degrees of deformation in the western states. But in New York, no such tangible evidence of Cenozoic events exists. The Coastal Plains sediments derived from the long-continued degradation of New York and New England now rest on the Continental

Reference A-4

Frimpter, M.H., Groundwater Resources, Allegheny
River Basin and Part of the Lake Erie Basin, New York,
New York State Department of Environmental Conservation,
Albany, New York, 1974.

Ground-Water Resources, Allegheny River Basin and Part of the Lake Erie Basin, New York

By

Michael H. Frimpter

U.S. Geological Survey

Allegheny River Basin
Regional Water Resources
Planning Board

ARB-2
1974

New York State Department of Environmental Conservation

GROUND-WATER RESOURCES, ALLEGHENY RIVER BASIN AND PART OF THE LAKE ERIE BASIN, NEW YORK

Prepared for the
ALLEGHENY RIVER BASIN REGIONAL WATER RESOURCES
PLANNING BOARD

By

Michael H. Frimpter

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

in cooperation with
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

STATE OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Basin Planning Report ARB-2
1974

INTRODUCTION

Abundant ground-water resources in the New York part of the Allegheny River basin are an asset to the development of southwestern New York. Much of the water used for municipal, industrial, and private supplies in this basin is obtained from wells and springs. The adjacent Lake Erie drainage basin in Chautauqua County is not as well endowed with ground water, and nearly all municipal and industrial supplies in this area depend on artificial surface-water reservoirs or on Lake Erie.

In the past, development of the area was concentrated in the major valleys where the land is most suitable for cultivation and construction and where ground water is most plentiful. Today cities and villages are expanding within the valley areas, and some are beginning to expand beyond the limits of the valleys. Suburbanization is occurring near some of the larger industrial centers such as Dunkirk, Jamestown, and Olean. Distribution and quality of the water will influence future population movement and industrial development in the area.

Irregular distribution of ground-water availability in the study area is an important feature of the resource. Nearly all the ground water available in quantities sufficient to sustain municipal and industrial water supplies is in the major valleys of the Allegheny River basin. In upland areas, only moderate to meager supplies of ground water are available for supply to individual homes or farms.

Problems with water quality are superimposed on the problem of geographical distribution of the water. Much of the small amount of available ground water underlying the Lake Erie Plain is too salty for most purposes. In this area, ground water from depths greater than about 50 feet is too salty for domestic use. This saltiness is due to connate water (water entrapped in the rock forming sediments when they were deposited in an ancient sea). Concentrations of iron and manganese in water from some aquifers is sufficiently high to require treatment before domestic use. Man's pollution of ground water with organic wastes and chemicals has also reduced the availability of good-quality water. Oil-field brine is a pollutant of ground water in and near active oil fields in the Allegheny River basin. Some of the aquifers with the largest potential yields in southwestern New York are particularly susceptible to pollution.

Water levels are declining in some aquifers because pumpage from them exceeds recharge. Declining water levels in the Jamestown aquifer caused concern about the adequacy of the Jamestown water supply. This concern led the city of Jamestown into a cooperative agreement with the U.S. Geological Survey to study the ground-water resources of the Jamestown area (Crain, 1966).

Purpose and Scope

The purpose of this report is to describe and evaluate geologic and hydrologic conditions controlling the ground-water resources of southwestern New York State as a guide for regional planning and management of the area's water resources. Specific attention was given to the determination of possible perennial yields of ground water from the major aquifers. Distribution of the aquifers, their estimated perennial yields, and estimated yields of wells tapping them are shown on maps; geohydrology of the major aquifers is described and illustrated.

The area studied includes the parts of Allegany, Cattaraugus, and Chautauqua Counties in the Allegheny River drainage basin and the part of the Lake Erie drainage within Chautauqua County, exclusive of Cattaraugus Creek basin (fig. 1). This area includes 2,200 square miles bounded by Cattaraugus and Genesee basins on the north and east, by Lake Erie on the northwest, and by the Commonwealth of Pennsylvania on the west and south. Major centers of population in the area are Dunkirk, Jamestown, Olean, and Salamanca.

Most of the area lies within the Appalachian Plateau physiographic province, except for a narrow 2- to 5-mile wide belt along the Lake Erie shore and in the Great Lake section of the Central Lowland east of the Mississippi physiographic province (Fenneman, 1938, pl. IV).

Hydrologic Data

Geologic mapping and collection of hydrologic information were done in 1967. Records of 452 wells and 5 springs are included in tables 4 and 5, respectively. Lithologic logs from 176 selected wells and test borings are shown in table 6, and chemical analyses of 73 representative samples of ground water are given in table 7.

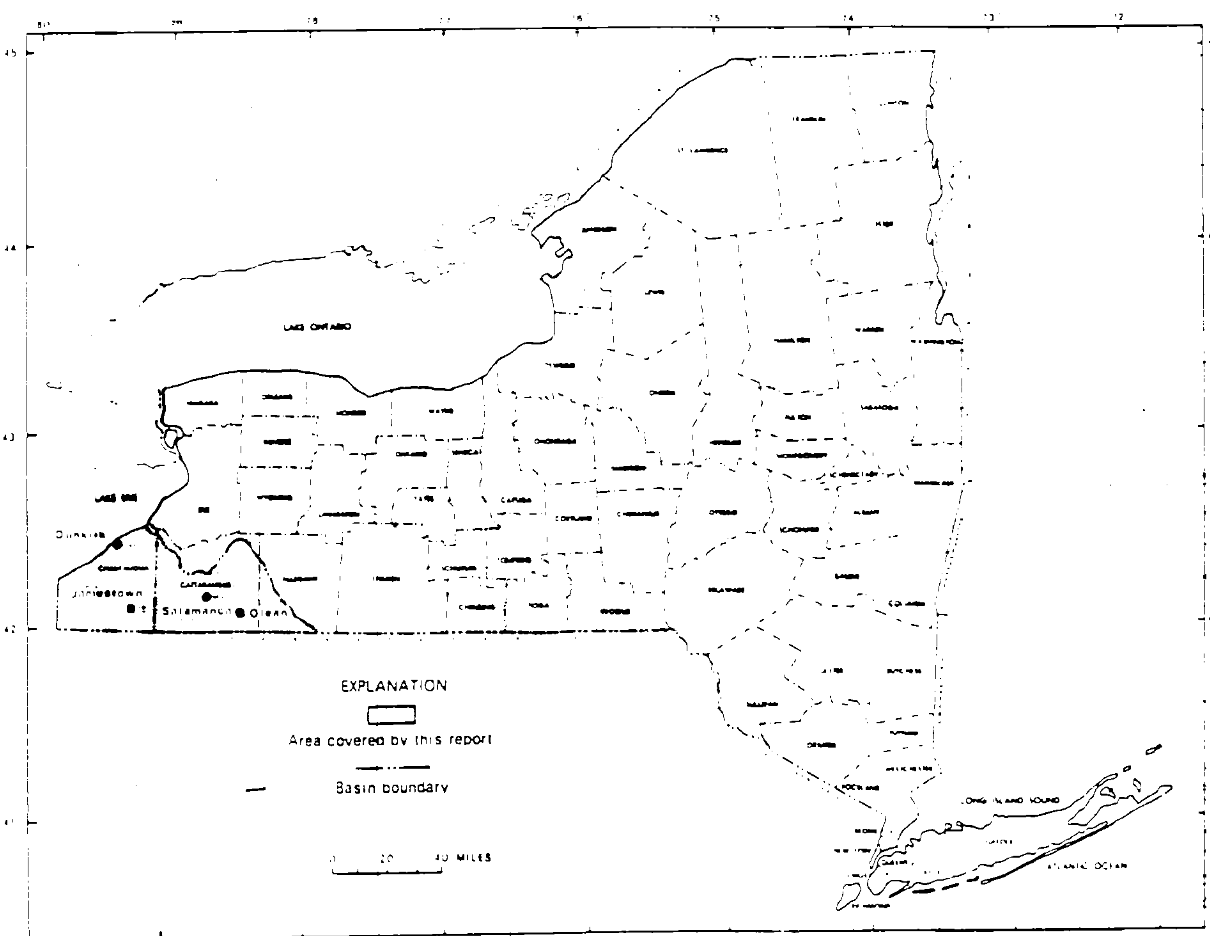


Figure 1.--Location of study area.

Numbering and Location System

Well, spring, and test-hole basic data used in the preparation of this report are identified by latitude, longitude, and a sequential number or letter. These identification numbers allow location of the well, spring, or test hole to within 1-second accuracy (about 100 feet in the study area) on U.S. Geological Survey 1:24,000 scale topographic maps (fig. 2). Further identification within a 1-second quadrangle is by a sequential number for wells and springs or a sequential letter for test holes. Identification number 420004N0781647.1, for example, locates well sequential number 1 in a 1-second quadrangle between latitudes 42°00'04" N. and 42°00'05" N. and between longitudes 78°16'47" W. and 78°16'48" W.

Previous Investigations

A report on the ground-water resources in the area around Jamestown (Crain, 1966) deals principally with hydrology and perennial yield of the Jamestown aquifer. Very little new information pertaining to ground water in the Jamestown area has become available since the publication of Crain's report, and no attempt was made to supply additional estimates of ground-water availability for that area.

A description of the ground water in the Allegany State Park (Thwaites, 1932) provides historical information on the quality of ground water and construction of wells and springs in the park area.

Acknowledgments

This report was prepared in cooperation with the New York State Department of Environmental Conservation, for the Allegheny River Basin Regional Water Resources Planning Board. U.S. Geological Survey studies of surface-water resources and quality of surface water were made concurrently with this study under the same cooperative agreement. Well records from previous U.S. Geological Survey inventories of ground-water supplies were particularly valuable to the study.

The investigation was made under the direct supervision of Albert M. LaSala, Jr., former Chief, Areal Studies Section, and under the general supervision of Garald G. Parker, former District Chief, U.S. Geological Survey, Albany, New York. Ronald R. Shields prepared the part of this report pertaining to ground water as part of the hydrologic cycle. Lynn E. Johnson and Richard E. Krause collected well data and ground-water samples for the project during 1967, and Willard S. Winslow, Jr., collected many useful well records during the mid-1940's.

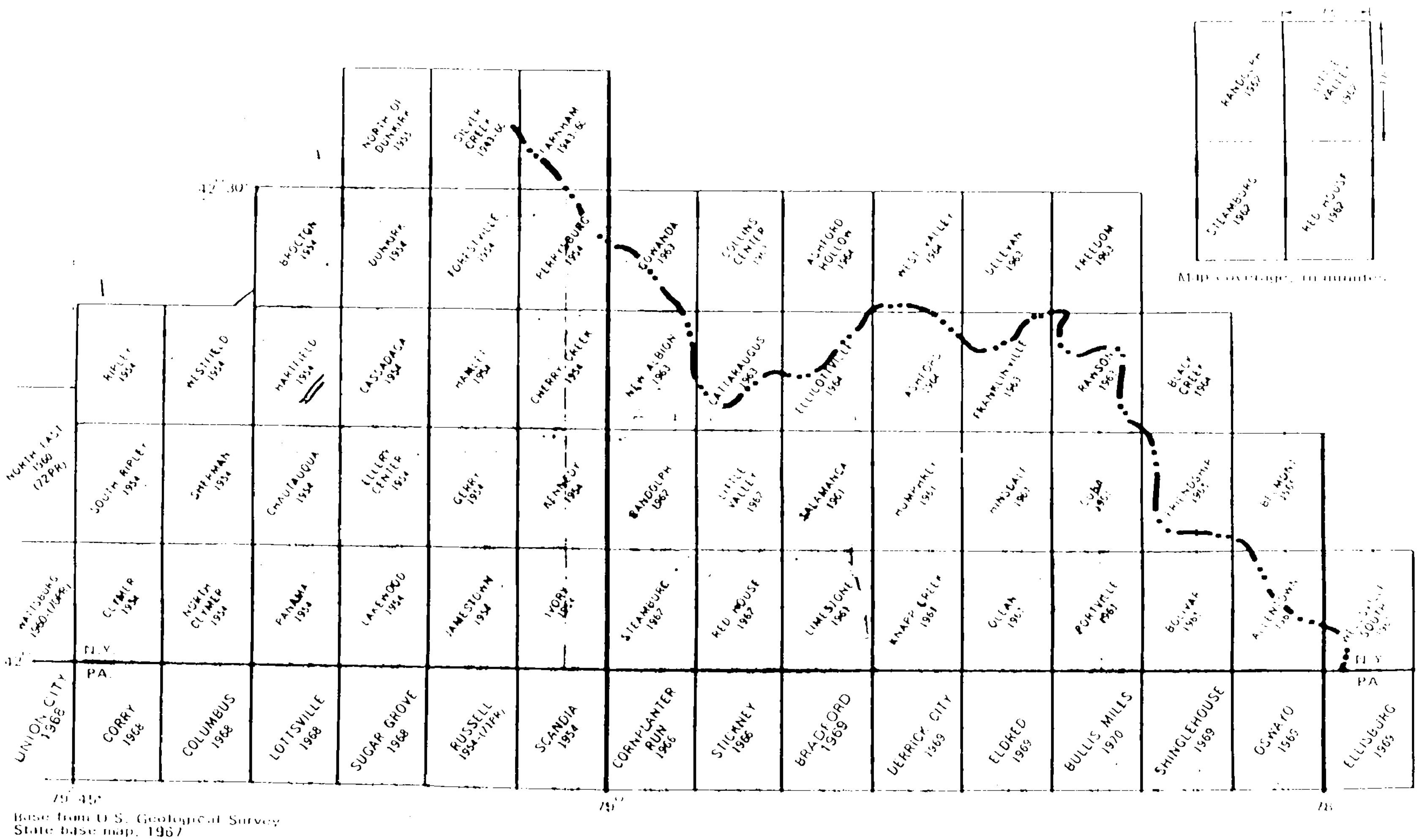


Figure 2.--Index to U.S. Geological Survey topographic maps, as of October 1972, covering the Allegheny River basin, New York.

Locations (latitude-longitude) in this report can be plotted on appropriate U.S. Geological Survey topographic maps. These maps are currently priced at $.75 a copy. They may be ordered from the Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202.

GEOLOGIC SETTING

Bedrock at and near the land surface in the study area is of Devonian age and consists predominantly of gray and black shale with interbedded layers of gray siltstone and sandstone (fig. 3). These rocks were deposited in a shallow sea about 350 million years ago. Layers of shale, siltstone, and sandstone dip very gently to the south, and rock layers that crop out in the northern part of the area are at great depth near the New York-Pennsylvania boundary to the south. For example, the Bradford First sand (sandstone), which is penetrated by oil wells at a depth of about 1,200 feet at Knapp Creek, is equivalent to a layer that crops out near Cuba, 18 miles to the north-northeast. Oil seepage to the surface from this layer, near Cuba, forms the famous Seneca Indian Oil Spring.

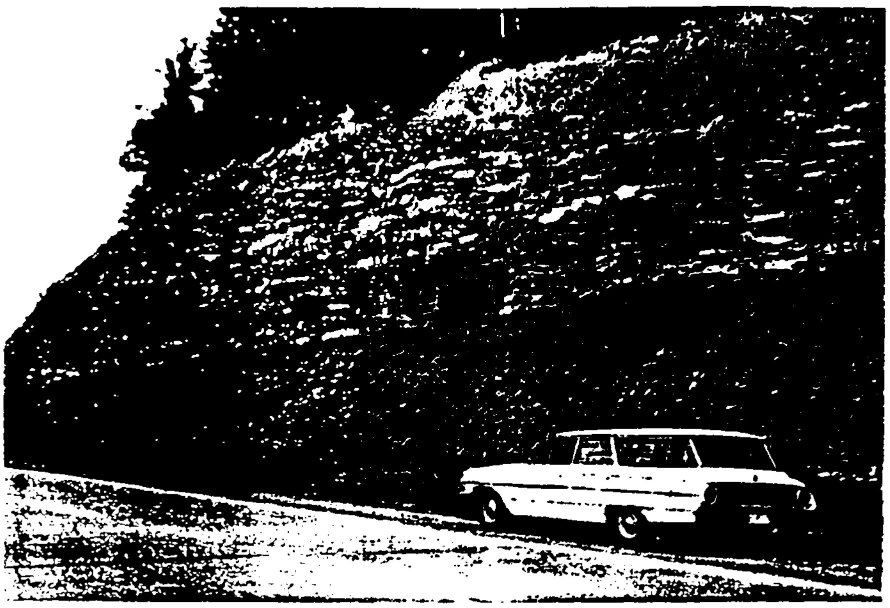
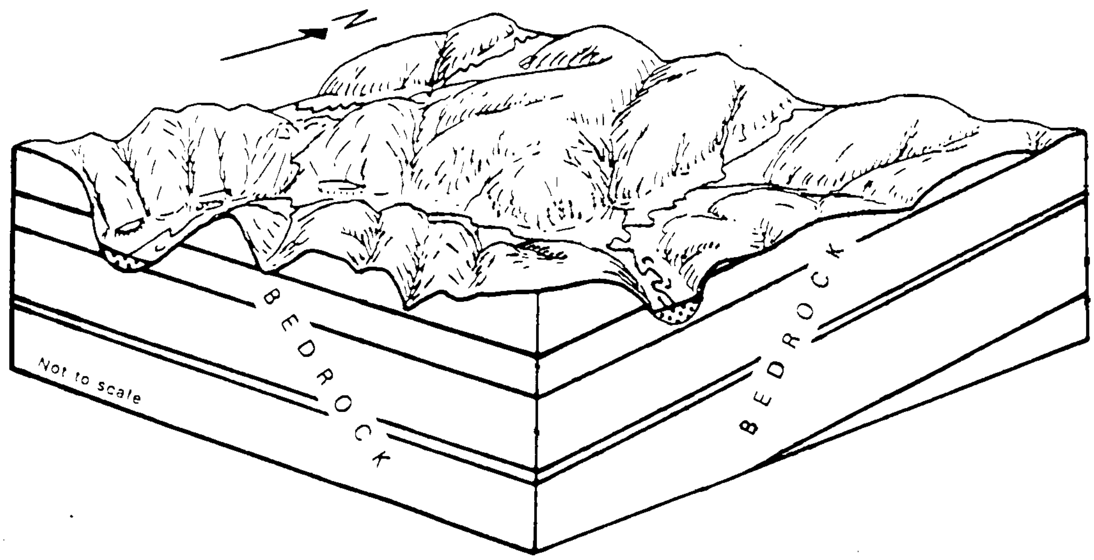


Figure 3.--Eastward view of gently dipping shale and sandstone bedrock near Irvine Mills.



EXPLANATION

Thick unconsolidated deposits

Figure 4.--Mature dissected Allegheny Plateau.

Most of the area is a dissected plateau in a mature stage of development as indicated by the sharp divides between valleys (fig. 4). The plateau ends in an irregular escarpment at the Lake Erie Plain, a few miles southeast of Lake Erie. The Lake Erie Plain is a narrow belt of nearly flat land, sloping gently from the base of the escarpment, about 800 feet above sea level, to the lake shore, about 570 feet above sea level. Nearly all the rocks exposed at land surface in the study area are of Devonian age, but small areas of rocks of Mississippian and Pennsylvanian age are exposed on the hilltops near the New York-Pennsylvania State line at altitudes of about 2,300 feet. Detailed descriptions of the bedrock geology in the study area have been made by Lobeck (1927) and Tesmer (1963), and the locations of the geologic formations are shown on the geologic map of New York State (Broughton and others, 1962).

A mantle of unconsolidated deposits covers nearly all the bedrock in the area (fig. 5). In most localities, the mantle is thin on hilltops and hillsides and is thickest in the larger valleys. Most of the available, good-quality ground water is in thick, unconsolidated deposits in the valleys.

Most of the study area was covered at least twice by continental glaciers during the Pleistocene Epoch (between about 1 million and 10 thousand years ago). The glaciers moved from Canada southward across the area. Rock fragments embedded in the ice abraded the bedrock, and additional rock fragments and soils became incorporated in the ice sheets. Hilltops were rounded, and valleys parallel to the direction of ice movement were deepened by glacial erosion.

Before the advance of the glaciers, the topography of the area was probably similar to that in Allegany State Park, south of Salamanca. The south-central part of the study area near Salamanca, in which the park lies, is the only part of New York State that was not glaciated (MacClintock and Apfel, 1944). There is little flat land in this nonglaciated area, and all its streams are in deep V-shaped valleys separated by sharp ridges.

As the glaciers melted from the area, morainal ridges were formed at edges of the ice by the deposition of soil and rock fragments where ice fronts were stationary. Some moraines may have been pushed short distances from their original sites by minor readvances of the ice fronts.

Glaciation is responsible for derangement of the surface drainage system of the area. Most of the preglacial drainage channels were dammed by glacial ice or moraines. Such damming caused lakes to form in some places and diverted some streams to new channels. Before glaciation, most of the streams in the area drained toward the north; however, areal drainage has been southward since Pleistocene time. Examples of drainage disruptions (stream piracy) are given in the remainder of this section.

Prior to glaciation two branches of the ancestral Allegheny River met at the site of the abandoned hamlet of Cold Spring and flowed northwest through Little Conewango Creek valley, the upper part of Conewango Creek valley, past the present locations of Dayton and Gowanda (fig. 5), and northwestward to Lake Erie. A moraine deposited in the ancestral Allegheny River valley between Randolph and Cold Spring formed a dam between Conewango Creek and the present Allegheny River (fig. 6). This moraine blocked drainage and dammed the Allegheny River to form a deep sinuous lake that spilled over a divide at Kinzua in Pennsylvania into a tributary of the Ohio River. A gap that the stream rapidly cut in the soft bedrock at Kinzua allowed the lake to drain completely. Consequently, the upper Allegheny River is now part of the Ohio River drainage system.

As the glacial ice receded to the Allegheny Plateau escarpment, large fingerlike lakes formed in the present valleys of Conewango Creek, Cassadaga Creek, and Chautauqua Lake. The moraine near Randolph prevented these lakes from draining southward into the Allegheny River, whereas the glacial ice itself prevented northward drainage. Because great amounts of silt and clay were deposited in the lakes, today the Cassadaga and Conewango Creek valleys are land; and more than half of Chautauqua Lake is less than 20 feet deep.

Ancestral Beaver Meadows Creek, Ischua Creek, and Oil Creek drained to the north; but their valleys were also dammed by glacial ice. The ice front remained at the north ends of these valleys long enough to build sizeable moraines that presently form drainage divides at Mayville, Cassadaga, Dayton, Lime Lake, Rawson, and at other, less prominent locations. The ice blocked drainage to the north, and lakes were formed. Because the melting glacier produced more water than the valleys could hold, the lakes spilled over divides to the south into tributaries of the Allegheny River and eventually drained in a manner similar to that of the Allegheny River. At Lime Lake, sediment-laden melt water discharged from the glacier into Ischua Creek valley and deposited beds of nearly horizontally layered sand and gravel. These beds were partly removed by erosion when the lake drained to the south.

EXPLANATION

SURFICIAL DEPOSITS

Sand or interbedded sand and gravel

Silt, clay, or silt and clay

Till mixed with sand and gravel, and silt and clay. These deposits were usually formed as glacial moraines.

Glacial till or bedrock

Areas that have not been glaciated and whose surficial deposits have been derived from weathering of the underlying bedrock.

Contact

Southern limit of Wisconsin glaciation

Basin boundary

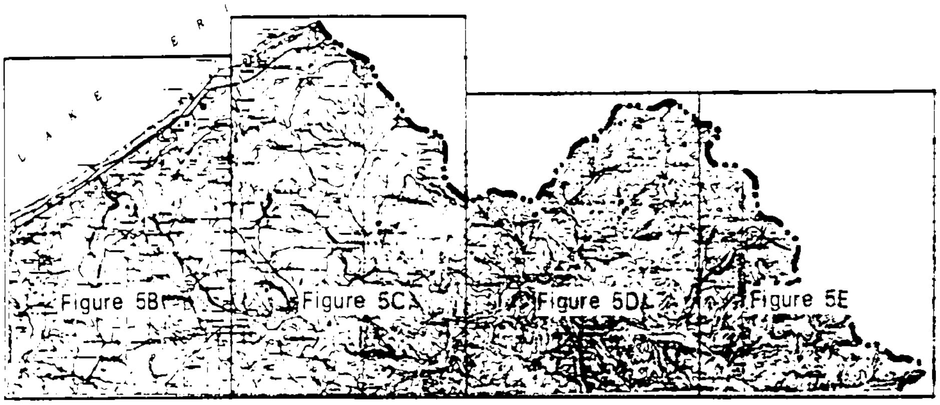


Figure 5A.--Surficial geology, Allegheny River basin, New York. (Geology for Chautauqua County adapted from E. H. Muller, 1963. Geology for remainder of basin by M. H. Frimpter, 1967.)

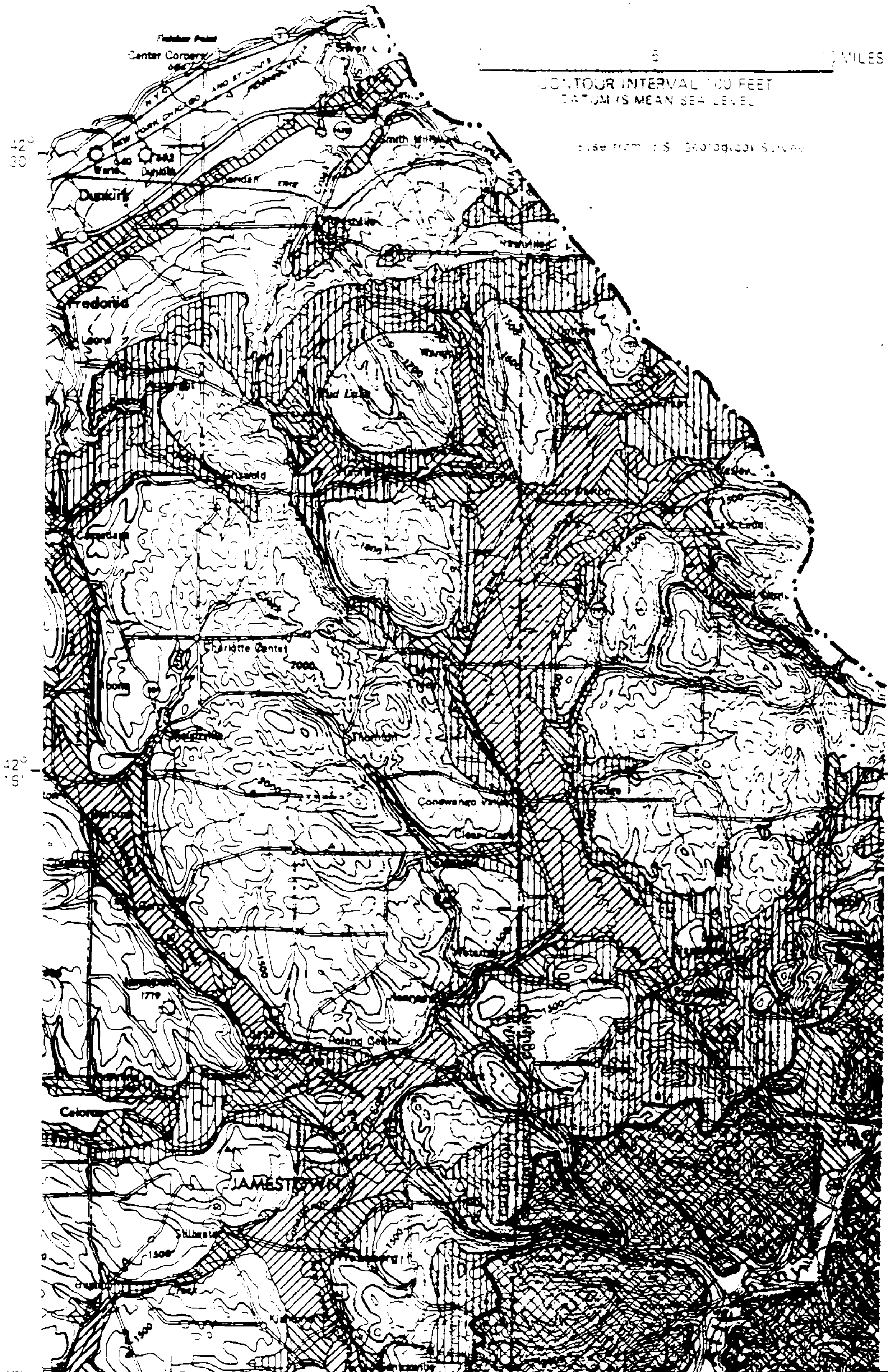
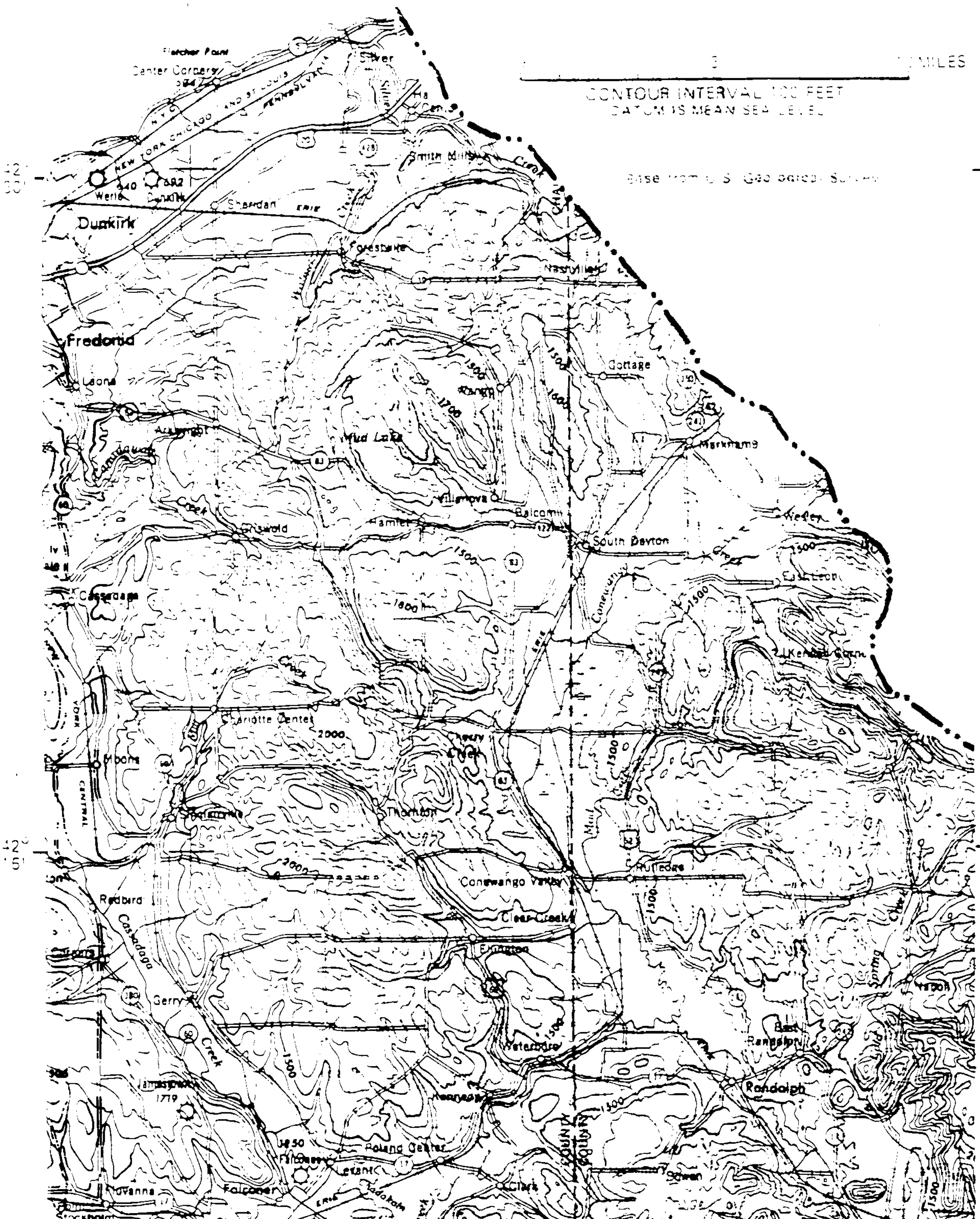


Figure 50.--Surficial geology, Allegheny River basin, New York (western-central part).



BASE MAP FOR FIGURE 5C

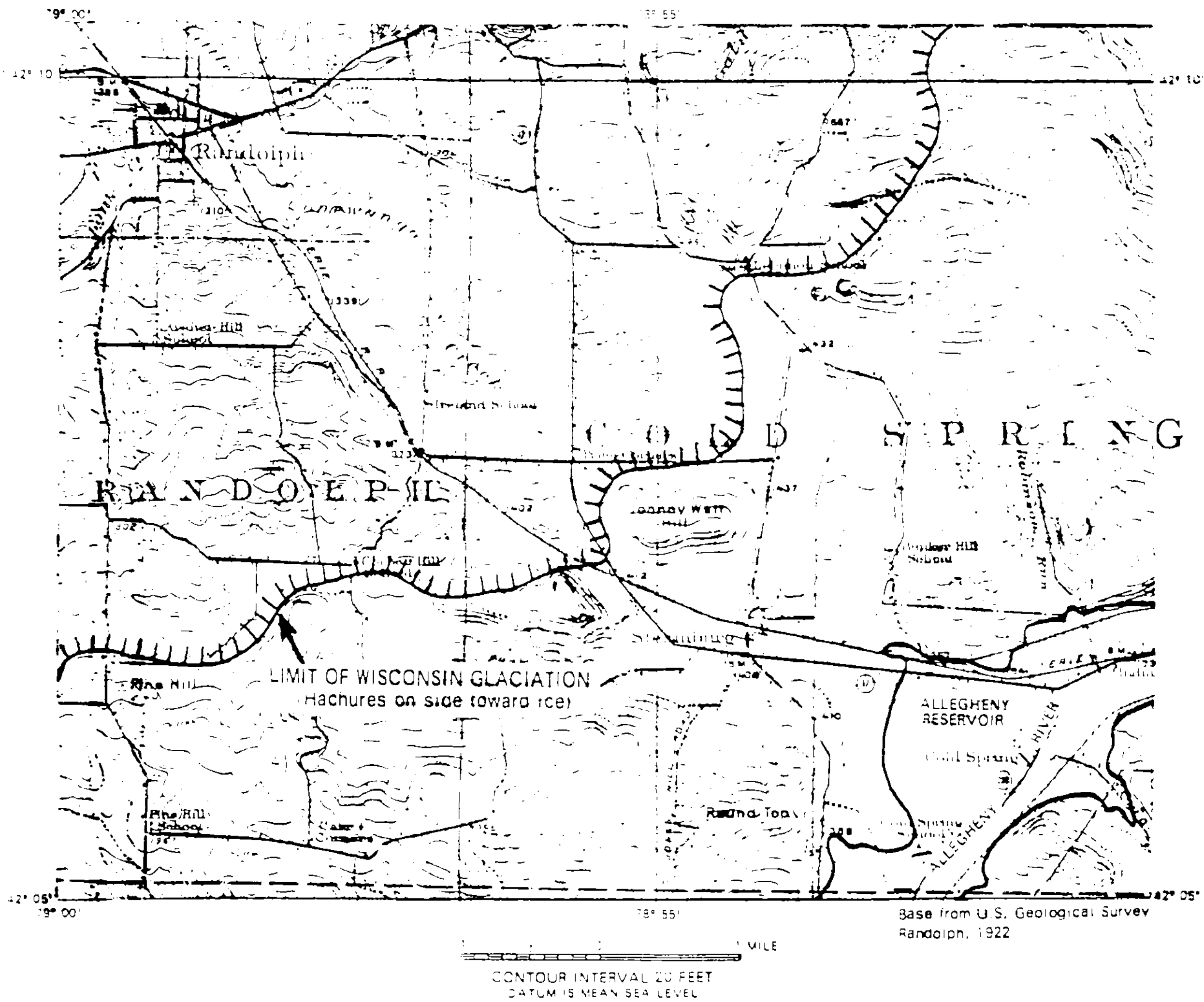


Figure 6.--Location of moraine blocking ancestral Allegheny River valley.

GROUND WATER AS PART OF THE HYDROLOGIC CYCLE

Ground water in the area is derived from precipitation. There are three paths by which water from precipitation may leave the area: (1) over the land surface, (2) through the ground, and (3) back to the atmosphere through evapotranspiration. In the first path, precipitation runs off the land surface directly into streams. In the second path, it infiltrates the soil where some of the water is temporarily retained as soil moisture and the rest percolates downward, through the zone of aeration, to the water table (upper limit of the zone of saturation). Then as ground water, it moves laterally to discharge into lakes and streams. The third path is evapotranspiration from vegetation and land and water surfaces. The pattern of subsurface water circulation is shown in figure 7.

Estimates of the average annual water budget for the study area can be made with the equation $P = R + L \pm Sg$ (1)

where P = precipitation on the area
R = runoff from the area
L = water loss by evapotranspiration from the area
Sg = change in ground-water storage

Assuming that the change in ground-water storage is negligible in comparison to total inflow and outflow for the 30-year period (1931-60),

$Sg = 0$, and equation (1) may be simplified to:

$$P = R + L \qquad (2)$$

Average annual precipitation for this period in the Allegheny River basin is 41 inches, and runoff is 22 inches. By substituting these data in equation (2), one can calculate that the estimate of average annual evapotranspiration in the Allegheny River basin is 19 inches.

The ground-water budget for an area can be developed by determining how much of the water is circulated through the ground-water system, using the following equation:

$$Pg = Rg + ETg \pm U \qquad (3)$$

where Pg = ground-water recharge
Rg = ground-water discharge to streams
ETg = ground-water evapotranspiration
U = Subsurface outflow or inflow

Under natural conditions, aquifers of the study area are recharged by either direct infiltration from precipitation or leakage from streams that cross the aquifers. The natural rate of recharge is controlled primarily by the vertical permeability of the materials between land surface and the aquifers and also by the capacity of the aquifers to transmit water laterally away from the intake areas.

Using the general procedures outlined in a water-budget study by Rasmussen and Andreasen (1959, p. 93-97), the average annual ground-water

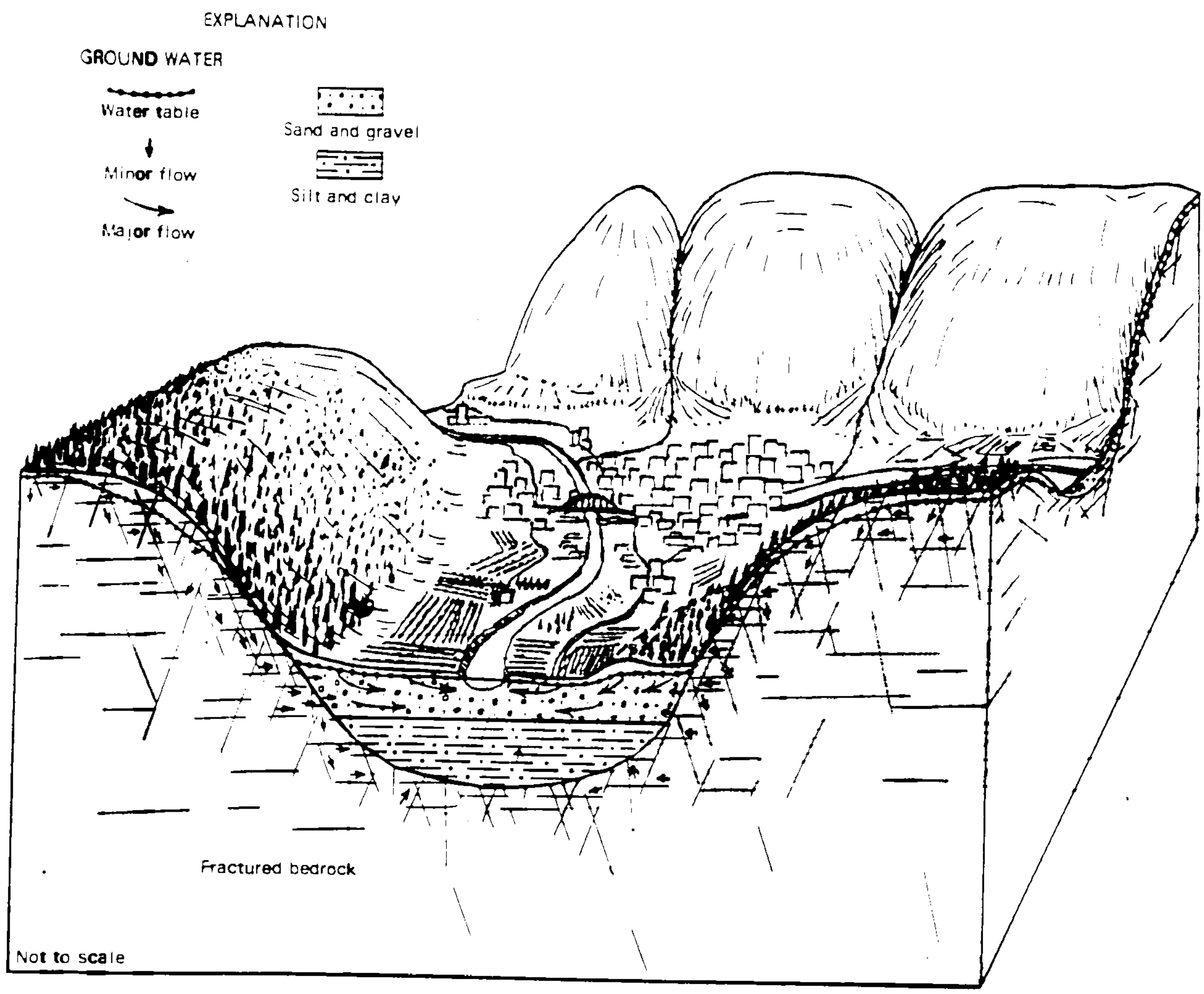


Figure 7.--Westward view of ground-water circulation near Olean.

recharge for the Allegheny basin, New York, from 1950 to 1964 was estimated to be 0.6 mgd (million gallon per day) per square mile. Ground-water discharge (Rg) was estimated to be 9.3 inches by separation of streamflow hydrographs into ground-water and streamflow components in the manner described by Meinzer and Stearns (1929, p. 107-113). By comparing ground-water runoff for various ground-water stages during both the growing season and the nongrowing season, a method described by Schicht and Walton (1961), the evapotranspiration of ground water (ETg) was estimated to be 3.3 inches. Underflow is assumed small enough to be considered negligible. The recharge estimate was determined by use of equation (3) as follows:

$$Pg = Rg + ETg$$
$$Pg = 9.3 \text{ inches} + 3.3 \text{ inches}$$
$$Pg = 12.6 \text{ inches } (0.6 \text{ mgd per sq mi})$$

The estimated ground-water recharge amounts to approximately 30 percent of the average annual precipitation.

Because of the absence of significant aquifers and the lack of detailed runoff data for the Lake Erie basin, a water budget for that basin was not prepared. Considering the general absence of permeable geologic formations on the Lake Erie Plain, ground-water recharge there is probably substantially less than the 12 to 13 inches estimated for the Allegheny River basin.

Figures developed in water-budget studies are based on a period of years, and individual years may vary considerably from the average. Furthermore, ground-water recharge takes place only when precipitation exceeds evapotranspiration and soil-moisture requirements and when the ground is not frozen. Consequently, the figures are broad approximations.

Hydrographs of water levels from observation wells are useful to illustrate the natural patterns of ground-water recharge and subsequent ground-water discharge. A 19-year hydrograph of a well in a water-table aquifer near Panama demonstrates seasonal fluctuations of water levels (fig. 8). A rising water table shows recharge to be greater than discharge during the non-growing season, from November to April. From April through October (growing season) aquifer discharge exceeds aquifer recharge because most of the precipitation reaching the land surface is returned to the atmosphere through evapotranspiration.

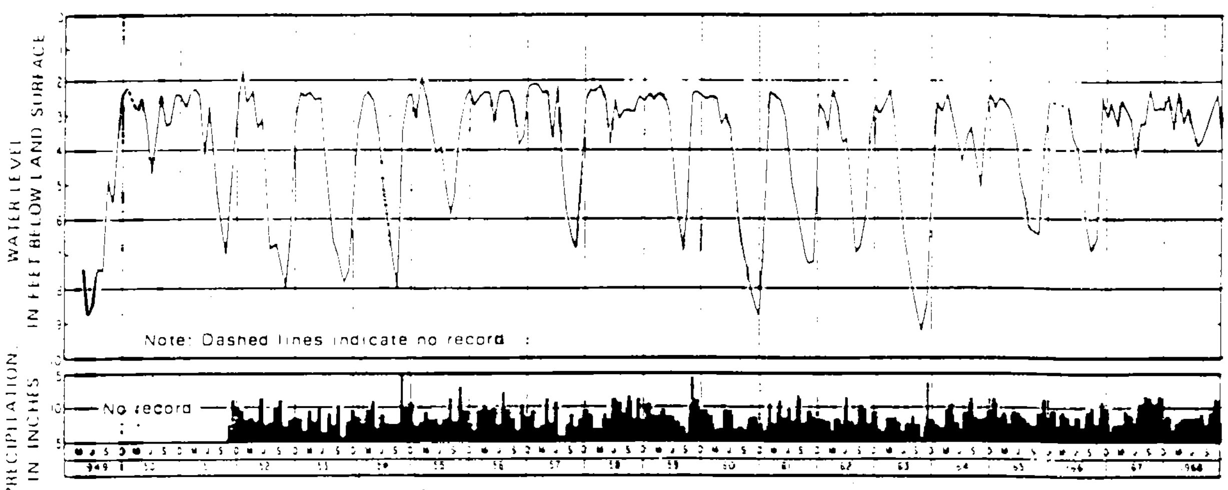


Figure 8.--Seasonal water-level fluctuations near Panama and monthly precipitation at Sherman.

OCCURRENCE OF GROUND WATER IN BEDROCK

Drilled wells tapping shale, siltstone, and sandstone (consolidated sediments) in most of the study area generally yield adequate quantities of good-quality ground water to supply rural homes. Only on the Lake Erie Plain and in the deep bedrock valleys of the plateau is the ground water too mineralized for domestic use. Objectionable concentrations of sodium, chloride, natural gas, and petroleum are carried by ground water in these areas. Shallow bedrock wells (less than about 50-feet deep) on the Lake Erie Plain may yield enough water of satisfactory quality to supply a home, but wells deeper than 50 feet usually yield salt water.

Regional ground-water circulation from the Allegheny Plateau area to the lower Lake Erie Plain is considered to be negligible. A significant circulation would have flushed the petroleum and the brine from the system in the past.

Ground water occurs in the pores of a rock; these pores may be classified as primary or secondary in origin. Primary porosity is developed at the same time the rock is formed. The primary pores in the rocks of the area studied are the void spaces between the grains of the sediment and are analogous to the spaces between marbles in a bag. Secondary porosity develops after the rock solidifies as cracks or fractures called joints.

The average primary porosity of the Bradford Third sand (the principal oil-bearing sandstone in the area) is about 14.5 percent, and its average permeability is a little less than 0.1 gallon per day per square foot (Fettke, 1938, p. 226). The low primary porosity and resultant low permeability of the consolidated rock in the study area as exemplified by the oil-bearing sandstone precludes the possibility of tapping consolidated rocks for large quantities of water.

Ground water obtained in usable quantities from the consolidated rocks occurs in the fractures or joints (secondary porosity). The more fractured and jointed the rock, the more open space it has to contain and transmit water. Horizontal or bedding-plane joints are very common in the study area, but they usually are tightly closed owing to the weight of the overlying rocks. However, at shallow depths or below competent beds of sandstone, these joints may be open and may carry water. Figure 3 is a photograph of an open bedding-plane joint from which water seeps and nourishes vinelike vegetation (above the automobile).

Wells in bedrock usually obtain most of their water directly from the horizontal joints because they intersect more horizontal than vertical joints. Horizontal joints in road cuts and other excavations seem to carry water, whereas the vertical joints seem to be dry because they are drained at the face of the excavation. (See figure 9.)

Although not as numerous as horizontal joints, steep-angle or vertical joints are very important in the area. These joints are more apt to remain open, even in less competent material such as shale, and to greater depths than the horizontal joints. Most importantly, the vertical joints act as conduits carrying recharge water from the surface down to the horizontal joints and form a three-dimensional network with the horizontal joints to transmit and store water below the water table.

Joint systems in the vicinity of Allegany State Park were recognized and described by Lobeck (1927, p. 93-96). He reported the parallelism of the vertical joints and the stream-valley orientation due to the adjustment of the streams to the zones of least resistance to erosion (the joints). Wells tapping consolidated aquifers in these valleys generally yield more water than those on hills. This is partly due to the greater number of joints in the valleys.

Also, wells tapping bedrock usually yield more water in valleys than on hills because the water table is nearer land surface in the valleys than it is on the hills and wells of equal length penetrate more water-saturated, jointed rock in the valleys. Furthermore, many streams in the valleys are sources of recharge; in most localities no recharge from streams occurs on the hills. Ground-water levels vary only a few feet throughout the year in valley bottoms, whereas water-level fluctuations in the hills may vary as much as a few tens of feet.

The average depth of 98 wells reported to tap bedrock for domestic supplies is 96 feet (table 4). Yields reported for 34 of these wells average 12 gpm (gallons per minute). The average depth of 28 wells drilled in bedrock for municipal, industrial, commercial, and other uses is 146 feet (table 4), and their average yield is 54 gpm. The difference in yield between these two groups of wells is not solely dependent on their differences in depth. The wells drilled for high yield are located more carefully than those drilled for domestic supplies, and they differ in construction and development.

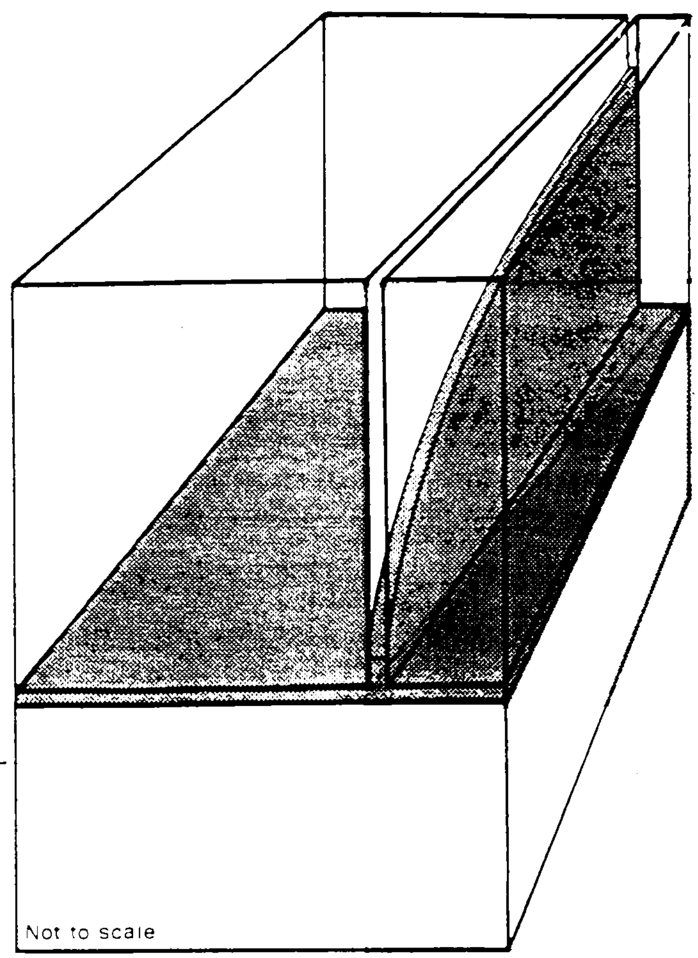


Figure 9.--Ground water (shaded area) in horizontal and vertical joints in bedrock.

OCCURRENCE OF GROUND WATER IN UNCONSOLIDATED AQUIFERS

Unconsolidated sediments comprise both the best and the poorest of the aquifers in southwestern New York (fig. 10). Coarse sand and gravel deposits are highly permeable and are capable of high yields. Compared to those deposits, clay is relatively impermeable and yields insignificant amounts of water to wells.

Most of the unconsolidated sediments were deposited during the last period of glaciation. Vast amounts of water and rock fragments were discharged from the melting glacier, and low-lying areas were flooded and were laden with sediments ranging in texture from clay to coarse gravel. In upland areas, most of the glacially derived sediments are deposits of till. Till is composed of unsorted clay, silt, sand, gravel, cobbles, and boulders in random mixtures. Conditions for deposition of till, outwash deposits, and lacustrine clay and silt coexisted at the edges of static-ice fronts, where moraines composed of mixtures of these materials were deposited. These moraines in the study area are mapped as "mixed deposits" (fig. 5).

Residual deposits formed from weathered bedrock in the nonglaciated part of the study area are similar to till in composition and hydrologic properties. Stream-laid deposits of sand and gravel occur in valleys in this area and are hydrologically comparable to outwash.

Thick, saturated, deposits of sand and gravel outwash in valleys (figs. 5 and 10) comprise the most productive aquifers in the study area. These deposits generally contain little interstitial clay and silt, and they are the most permeable of the water-yielding units in the area. The recharge potential of outwash deposits is the highest of all aquifers in the area because of their positions in valley bottoms. Outwash deposits are usually the most reliable aquifers because of their higher permeability and greater recharge potential. Yields of more than 1,500 gpm have been obtained in the study area from properly constructed wells screened in outwash. Stream-laid deposits of sand and gravel in the nonglaciated area derived from local rocks are similar to outwash, but they are mostly of small areal extent.

Deposits of till are usually of low permeability, and they do not yield large quantities of water. However, these deposits can usually supply individual homes and small farms from large-diameter (3 or more feet) wells. Such wells are usually shallow and frequently become dry in periods of drought; furthermore, they are easily polluted.

Many of the moraine deposits lie above the water table, especially where the deposits were left as ridges and hummocks. Where these deposits lie below the water table, intercalated sand and gravel lenses are capable of yielding small to moderate amounts of water. Yields from the moraines are variable, but in many localities, depending on the composition and the location of the saturated morainal material, they are capable of supplying individual homes and small farms from small-diameter driven wells or large-diameter dug wells.

Lake deposits of clay and silt in the area have low permeability and are not considered as aquifers. Clay and silt deposits may confine water under artesian pressure in underlying aquifers.

EXPLANATION

Estimated yield to individual wells tapping the most productive aquifer underlying each area. Yields are based on permeability, thickness, topographic position, and reported yields of existing wells. Several areas have more than one aquifer, but only the yield of the most productive one is indicated.

YIELD, IN GALLONS PER MINUTE

0.1 to 20

These aquifers consist of glacial till, bedrock, and very small deposits of sand and gravel. Open-hole drilled wells are constructed in the bedrock. Large-diameter open-jointed field stone wells are constructed in the glacial till and shallow sand and gravel deposits. Well points are also used to tap the small sand and gravel deposits.

5 to 50

Sand and gravel aquifers of slight thickness, including moraines, both water table and artesian. These are tapped by fully penetrating screened wells, generally 6 inches or less in diameter.

25 to 250

Sand and gravel aquifers, either water table or artesian. These deposits are tapped by fully penetrating screened wells generally 12 inches or less in diameter.

250 to more than 1000

Very permeable sand and gravel aquifers, either water table or artesian. Thickness of the water-table aquifers is generally more than 20 feet and of the artesian aquifers is generally less than 20 feet. These are tapped by fully penetrating screened wells, generally 10 inches or more in diameter.

Area boundary

Basin boundary

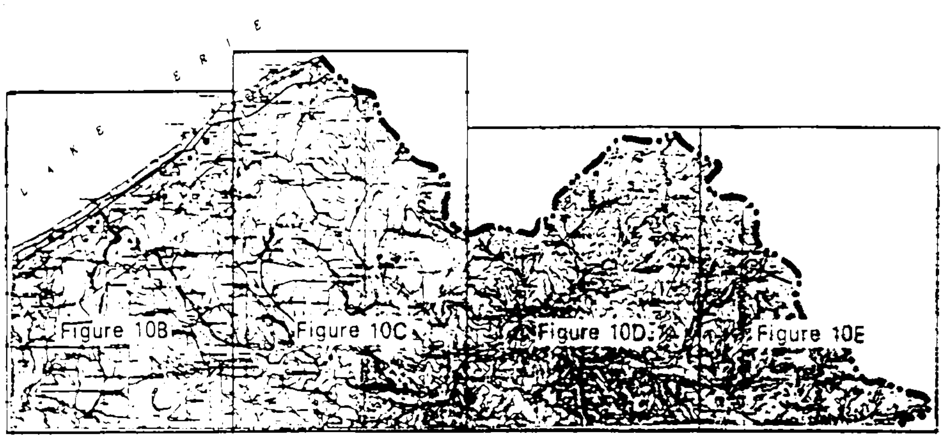


Figure 10A.--Ground-water availability, Allegheny River basin, New York.

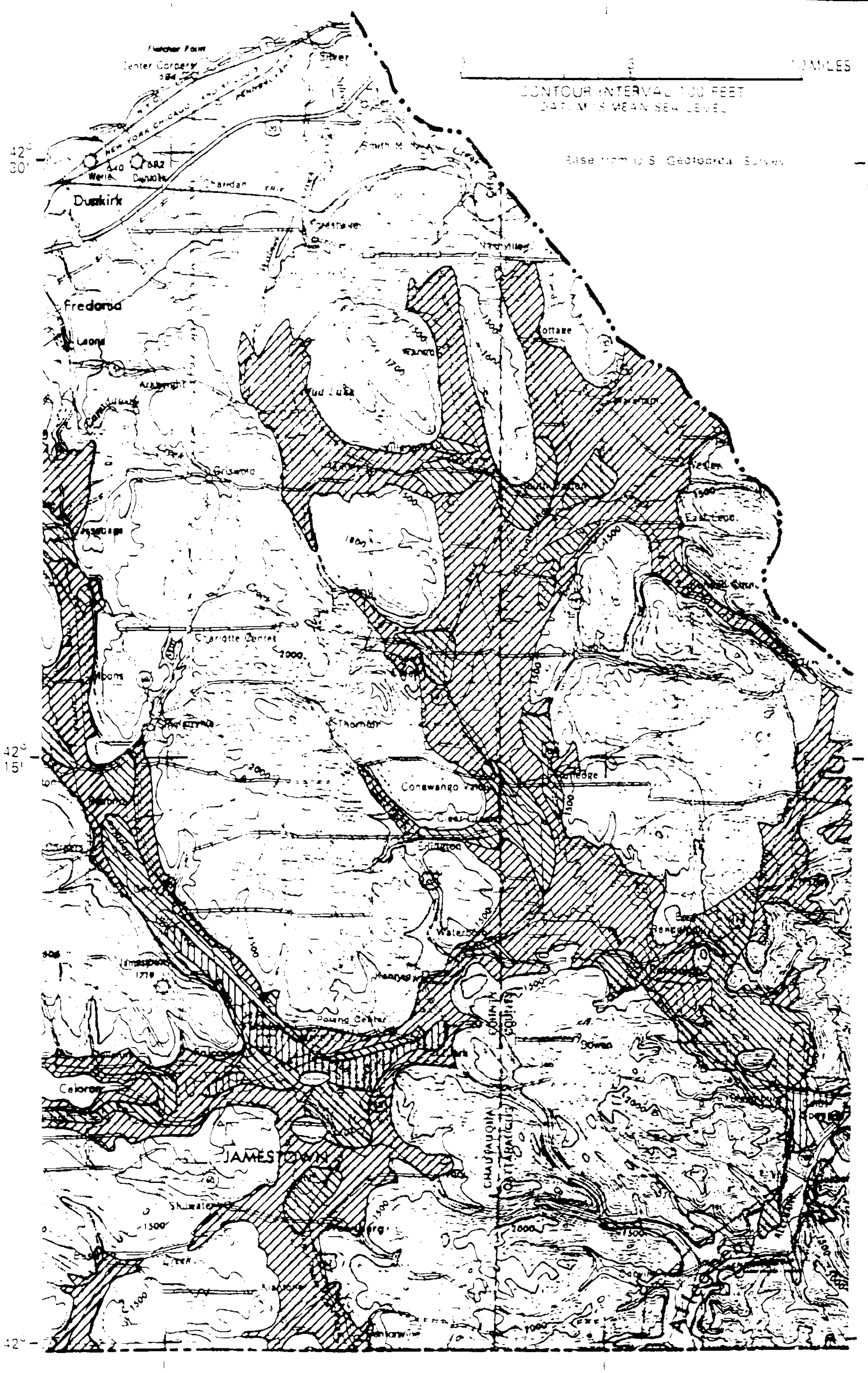
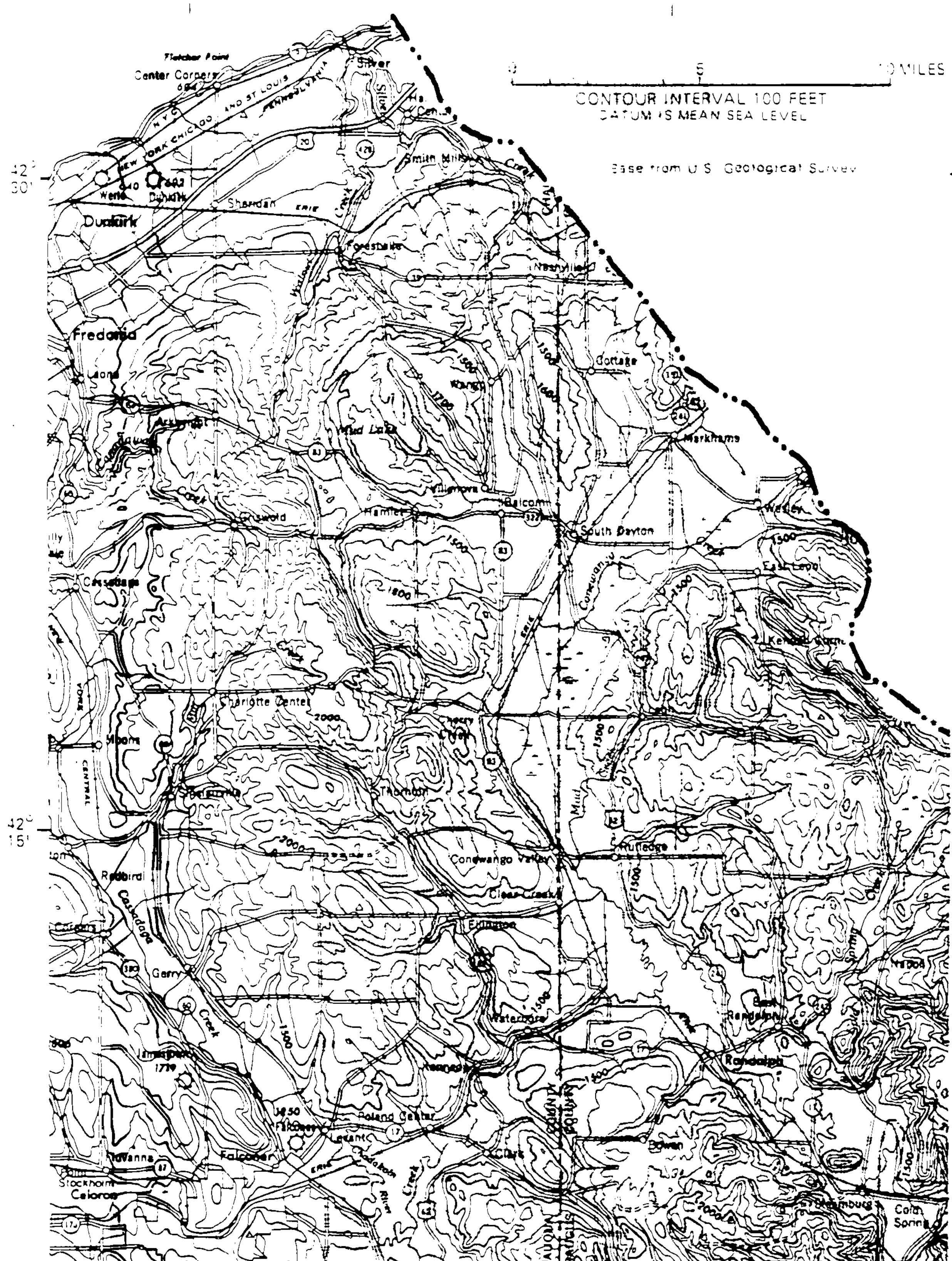


Figure 10C.--Ground-water availability, Allegheny River basin, New York (western-central part).



BASE MAP FOR FIGURE 10C

Elongate deposits of sand and gravel running parallel to the Lake Erie shore consist of about 25 feet of sand and gravel and form a beach ridge. These deposits are not an important aquifer because water is not retained but drains rapidly toward Lake Erie. Only a very small thickness of the deposits is saturated. Locally, these deposits may serve as a source of water for domestic or stock uses.

Because the lithology (and hence the permeability) of the unconsolidated aquifers in the study area varies both vertically and horizontally, detailed estimates of ground-water availability from small segments of aquifers are not shown in figure 10 nor are they discussed in the text. Additional subsurface geologic and hydrologic data will be required before well-field development or well-field planning are undertaken. Arbitrarily placed wells of accumulative capacity equal to the aquifer yields presented in this report may not necessarily yield the total estimated aquifer yield when pumped simultaneously. A basic knowledge of well and aquifer hydraulics is assumed in presenting the potential aquifer-yield and well-yield data in the text and in figure 10. For information pertaining to the engineering aspects of well-spacing and location, the reader is referred to Meinzer (1923 and 1932), Heath and Trainer (1968), and Todd (1959).

The major unconsolidated aquifers of the Allegheny River basin in New York are described, and their potential yields are estimated in the remainder of this section of this report. These estimates represent the yields of the aquifers that could be sustained indefinitely. They are based on individual aquifer storage volume with complete recharge during each annual spring thaw and on the induced stream infiltration that would result from ground-water withdrawal. This method is applied because of the varying geohydrologic conditions existing in the aquifers in this section of New York State.

Aquifer discharge, measured as stream base flow, is complexly related to aquifer recharge in the Allegheny River basin and cannot be used as a direct estimate of potential ground-water yield as has been done in other areas of New York State. For example, because of the high permeability of valley aquifers and relatively steep valley gradients in lower Fivemile and Great Valley Creek valleys, both Fivemile and Great Valley Creeks lose rather than gain water when other streams of the area are in base-flow condition. Base-flow-stream discharge as a measure of aquifer recharge in these and other stream valleys in this study area would be misleading, and maps showing base-flow discharge are therefore not included in this presentation.

Aquifers in the Allegheny River Valley

A brief review of the Pleistocene geologic history of the Allegheny River valley helps explain the geologic framework of the valley. Before Pleistocene glaciation, the Allegheny River flowed northward and cut a steep-walled valley in shale and sandstone bedrock. The stream flowed northward through the present upper Conewango and lower Cattaraugus valleys, as part of the St. Lawrence drainage system. Advance of the glacial ice dammed this drainage and formed a long sinuous lake in the valley with a surface altitude of about 1,480 feet above present sea level. An approximately 211-foot thickness of clay and silt was deposited in the lake, and deltas of sand and gravel were deposited where streams entered the lake. To the south, the lake spilled over a divide near Kinzua, Pennsylvania; and the outflow eroded a channel to the Ohio River drainage system through which the lake drained. The glacier then advanced into the Allegheny River valley where it deposited large quantities of sand, gravel, and silt to form stratified valley-train deposits of more than 300-foot thickness at some places. After the Allegheny River subsequently cut through about 180 feet of these deposits near Quaker Bridge and Onoville, only a few high terraces along the valley sides remained.

Sand and gravel deposits extend from about 40 to 100 feet below the present river level and rest on as much as 200 feet of clay and silt. The sand and gravel deposits are generally thicker downstream and westward than they are upstream and eastward. Saturated sand and gravel deposits extend both upvalley and downvalley from Olean and constitute the most extensive high-yield aquifer in the study area (figs. 5 and 10). This aquifer is about as wide as the valley floor, averages about 80 feet in thickness, and extends from the Allegheny Reservoir, near Salamanca, upvalley into Pennsylvania. Typical geologic sections through the valley are shown in figures 11 and 12.

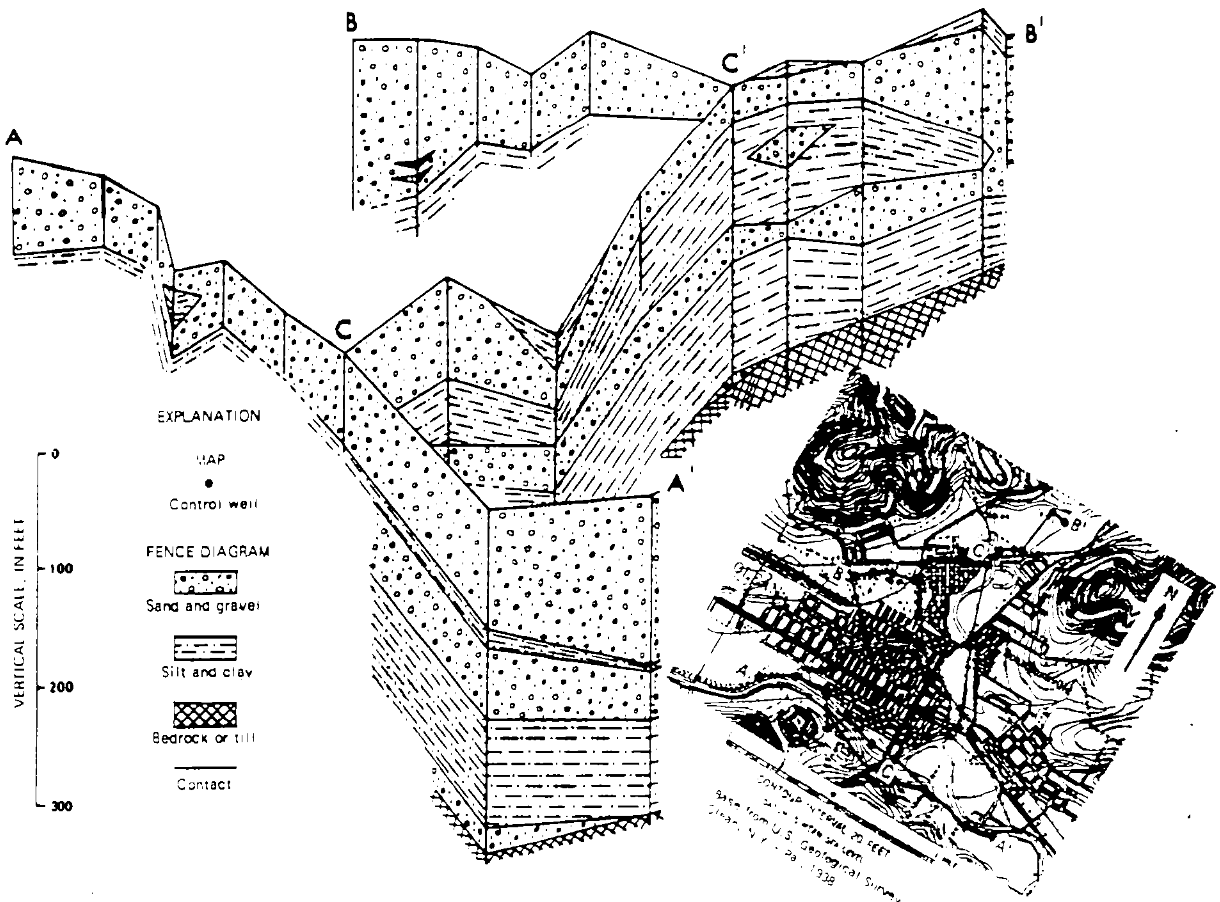


Figure 11.--Lithology of deposits at Olean.

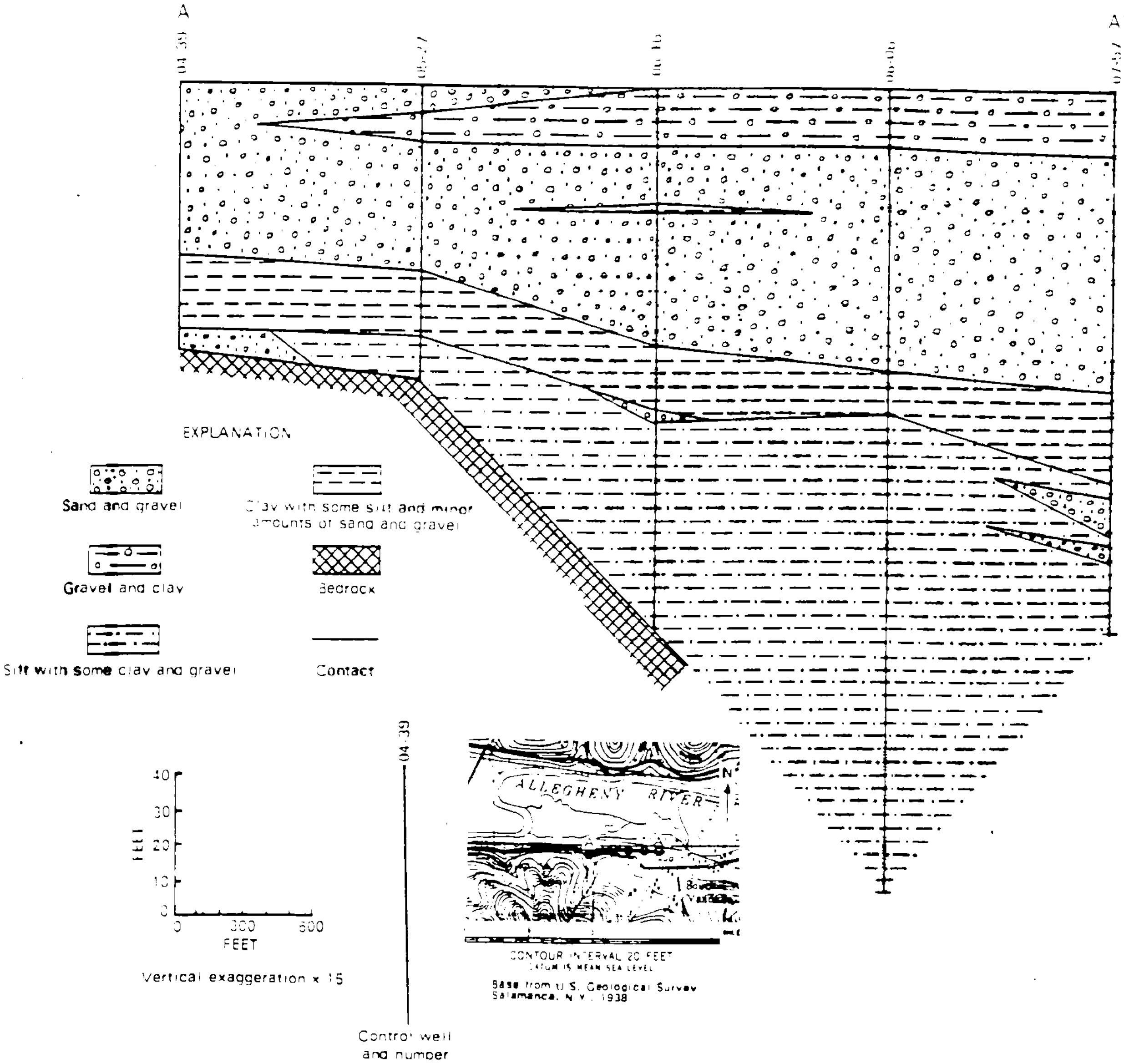


Figure 12.--Allegheny River valley near South Vandalia.

Because of lithologic variations, the aquifer permeability varies both horizontally and vertically. Some of the most permeable layers of the aquifer yield water at exceptionally high rates, as is evidenced by numerous screened wells that yield more than 1,000 gpm. Although depths to the most permeable parts of the aquifer may vary from place to place, the entire thickness of sand and gravel may be considered part of the aquifer and capable of yielding water.

The saturated unconsolidated deposits in the Allegheny River valley of the report area comprise a ground-water reservoir of about 20 square miles in area by an average of 80 feet in thickness. The amount of water stored in the deposits, using a specific yield (amount of water that can be drained by gravity from a given volume of material) of 20 percent, is about 65 billion gallons.

Under natural conditions, storage in the aquifer fluctuates only slightly. During summer and early fall, when the evapotranspiration rate is high, ground water discharging from aquifer storage constitutes the major source of the flow of the Allegheny River. During early spring, when streamflow is abundant and the evapotranspiration rate is low, the aquifer is recharged. However, because the aquifer is already nearly filled to capacity and the remaining storage capacity is rapidly replenished, most of the potential recharge is rejected and flows out of the study area. Much of this spring runoff might be stored in reservoirs for use during summer and fall when water is not so plentiful. The aquifer in the Allegheny River valley is a reservoir that could be available for this purpose.

Management of storage in the Allegheny River valley aquifer would significantly add to the area's water supply. To take advantage of the tremendous storage capacity of the aquifer, storage must be available for recharge during the period of abundant water in the spring. Greater lowering of the water table, by increased withdrawal and use of ground water to supply more industrial and municipal needs during the relatively dry period (about 200 days) from spring to fall, could make such storage space available.

Utilization of the storage capacity of the Allegheny River valley aquifer can be illustrated by computing yield from storage while temporarily ignoring potential-induced stream infiltration and assuming that 30 feet of the aquifer is dewatered in the 200-day period. The 30-foot average depth of dewatering is one-half the available drawdown in wells with screen open to the bottom 20 feet of an aquifer that is 80 feet thick. Excluding recharge during the period, approximately 170×10^8 cubic feet of aquifer would be dewatered; and a yield of 255×10^8 gallons of water (an average of about 120 mgd) would be obtained. During the remaining 165 days of the year, this volume of water would be replaced by recharge from the increased flow in the Allegheny River.

In addition to the 128 mgd drawn from aquifer storage, inflow from the Allegheny River and its tributaries is available as surface water or as ground water through induced infiltration. Inflows from the major tributaries and headwaters of the Allegheny River that are expected to be equaled or exceeded 90 percent of the time in average years (R. R. Shields, written commun., 1969) are:

	Cubic feet per second
Allegheny River at Eldred, Pa.	74
Oswayo Creek near Mill Grove, N.Y.	20
Olean Creek near Olean, N.Y.	26
Tunungwant Creek at Limestone, N.Y.	24
TOTAL	144 (93 mgd)

The 93 mgd streamflow during average years, or less during dry years, could be induced to recharge the aquifer through the Allegheny River streambed, which has an approximate area of about 44×10^6 square feet (32 miles long by 260 feet wide). With hypothetical withdrawal wells placed close enough to the Allegheny River to produce a maximum hydraulic gradient of 1 foot per foot, the minimum average streambed permeability necessary to induce infiltration of 93 mgd can be computed by Darcy's law, $P = \frac{Q}{IA}$:

where Q = quantity, in gallons per day
P = permeability of the streambed, in gallons per day per square foot
I = hydraulic gradient, in feet per foot
A = area, in square feet

$$P = \frac{Q}{IA}$$

$$P = \frac{93 \times 10^6}{1 \times 44 \times 10^6}$$

$$P = 2.1 \text{ gpd per ft}^2$$

This permeability is much lower than the expected 20 gpd per ft^2 (gallons per day per square foot) average permeability of the streambed material (Todd, 1959).

The 128 mgd from storage and the conservative estimate of 93 mgd of possible induced stream infiltration give a total of about 220 mgd of ground water available from the Allegheny River valley aquifer during the season when water is normally in shortest supply and in greatest demand. Induced infiltration of 93 mgd would be expected to cause the river to go dry 10 percent of the time in an average year and more than 10 percent in dry years. In addition to the stream inflows given, enough water flows through the Allegheny River near Salamanca 50 percent of the time to recharge the aquifer at an estimated induced infiltration rate of 880 mgd. This potential infiltration capacity, computed by Darcy's law, is based on a streambed permeability of 20 gpd per ft^2 and a maximum hydraulic gradient of 1 foot per foot. Because the potential induced infiltration is 880 mgd 50 percent of the time and the storage capacity of the reservoir can sustain a withdrawal of 128 mgd for 200 consecutive days, the ground-water yield of 220 mgd is considered a reasonable minimum estimate of the aquifer's potential yield.

The withdrawal figures are based on management practices of solely pumping from the existing surface- and ground-water reservoir system and are not dependent on return flow. Used water is or can be returned to the reservoir locally through septic tanks, cesspools, the riverbed, or other means. However, excessive recycling of such water could impair water quality in the aquifer. For yields exceeding 220 mgd, water-management and economic factors, rather than hydrology, are the dominant factors controlling the water yield of this river-aquifer system.

Production of ground water from the Allegheny River valley aquifer has been significant since about 1946. From 1946 to 1953, the Felmont Oil Corporation (formerly Case Pomeroy and Company, Inc.) withdrew more than 4.6 mgd from this aquifer for use in the water-flood method for the secondary recovery of petroleum at the Bradford oil field, in Pennsylvania. Production from the Felmont Oil Corporation's water-well field is shown in figure 13. This well field is on the south side of the Allegheny River, near Olean. Water from this field is no longer used in the secondary recovery of petroleum, but about 7 mgd is pumped to chemical plants in North Olean.

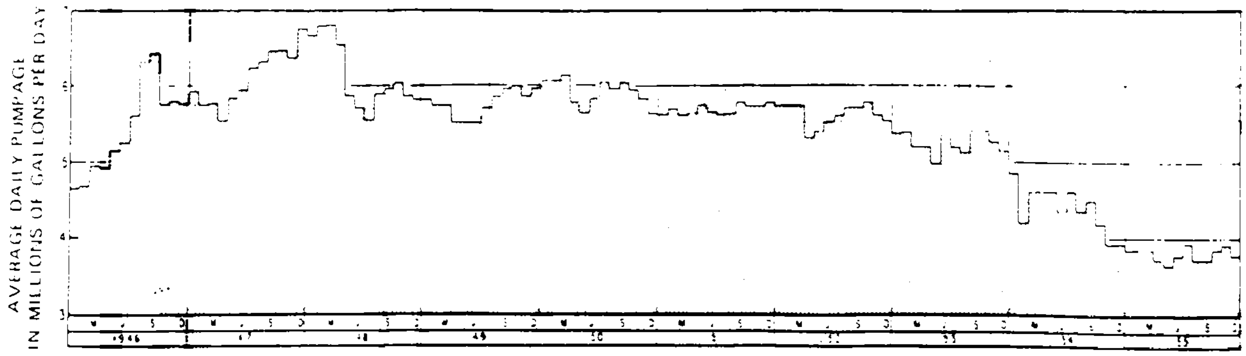


Figure 13.--Ground-water pumpage from Felmont Oil Corporation water-well field south of the Allegheny River.

Another field of six water wells owned by Felmont Oil Corporation was completed in 1966 at the chemical plants north of the Allegheny River. This well field produces an additional 7 mgd. In the fall of 1968, the Felmont Oil Corporation began testing the aquifer for additional wells near Olean.

The Pennzoil Company (formerly South Penn Oil Co.) operates water wells in the Allegheny River valley at South Vandalia. The water produced there is injected into an oil-bearing sandstone for secondary recovery of petroleum in the area of Chipmunk Creek Valley.

The highest-yielding water well at South Vandalia taps two separate sand and gravel aquifers and was pumped at 1,000 gpm with 20 feet of drawdown. Almost all the wells in the two water-well fields operated by Felmont Oil Corporation have been pumped at 1,000 gpm or more. Felmont well 420404N0782836.2 (table 4) reportedly yielded 1,420 gpm with 4 feet of drawdown. Test wells drilled in the Allegheny River valley, for the city of Olean, tapped the Allegheny River valley aquifer; and water-supply wells for Salamanca and the village of Allegany, as well as the wells supplying numerous small industrial and commercial establishments, also tap the Allegheny River valley aquifer. The ability of this aquifer to yield large quantities of water is well established.

Some wells tapping the Allegheny River valley aquifer have yielded hard water, and some have yielded iron-bearing water. Water quality is not uniform throughout the aquifer, and additional exploration is needed to define a quality-distribution pattern for the aquifer's water.

Aquifers in the Valleys of Conewango Creek Drainage Basin

This section describes the geologic framework and the hydrology of the three major stream valleys.

Aquifers in Chautauqua Lake, Cassadaga Creek, and Conewango Creek valleys have been described in detail by Crain (1966). During the advance of the glacier, the ice abraded, eroded, and enlarged these three valleys. As the glacier retreated, drainage from the valleys was blocked on the south by moraines and on the north by glacial ice and long deep lakes formed in the

CONCLUSIONS AND RECOMMENDATIONS

Ground water is available in sufficient quantities for industrial and public supply in the Allegheny River basin, primarily from unconsolidated aquifers in the valleys of the Allegheny Plateau. Lesser amounts of ground water, mostly in bedrock, in the uplands of the plateau are usually available for individual-home supply. Meager quantities of ground water, generally adequate for small domestic supplies, are available only from shallow depths in bedrock on the Lake Erie Plain.

The most productive aquifer in the study area is a water-table aquifer consisting of sand and gravel in the Allegheny River valley, upstream from the Allegheny Reservoir at Salamanca. This aquifer has a potential natural yield of more than 220 mgd, although such a large withdrawal would probably cause the river to go dry 10 percent of the time in average years and more than 10 percent in dry years. Smaller unconsolidated aquifers in both the fully and the partially glaciated tributary stream valleys of the Allegheny River drainage system can supply water needs for light industrial and public supplies.

Ground-water supplies are less adequate and are more expensive to develop in the western part of the Allegheny River basin than in the eastern part because significant aquifers in the western part are generally deep and artesian.

Bedrock aquifers in the area generally yield small quantities of ground water from bedding planes, fractures, and joints. In the upland areas, wells tapping bedrock usually yield enough water for home or farm supplies. Only on the Lake Erie Plain, and at depth in some valleys, is the bedrock aquifer unreliable as a water source. In these locations, water from bedrock is commonly too salty to be acceptable for domestic supply. In the valley areas, however, supplies of good-quality water can be obtained from unconsolidated aquifers.

Ground-water reserves in the New York part of the Allegheny River basin are estimated to be sufficient to supply the probable population of the area for many decades. The aquifers capable of yielding sufficient quantities of water are near the present urban centers and the areas of probable population and industrial growth. However, on the Lake Erie Plain, there are no aquifers capable of sustaining municipal or industrial water supplies.

One of the most significant potential problems associated with the area's aquifers is ground-water pollution. Aquifers underlie villages and cities in the area, and the increasing wastes from urban and industrial growth are likely to continue to be concentrated over the aquifers. The spatial relationship of water reservoirs (aquifers) and waste disposal poses a serious threat of pollution to the water supplies tapping these reservoirs.

This report is based mainly on geologic and hydrologic data available through 1967. As development of the study area proceeds and the need for water increases, more detailed subsurface geologic and hydrologic data will become available. Future studies, using these additional data, will enable refinement of the geohydrologic models and relationships presented in this report. Exploratory drilling and aquifer testing will most likely be required for future development of individual supplies. The information developed from such work is invaluable for continuing water-resources appraisal and development plans. Continual collection and central storage geohydrologic data would be advantageous for efficient maintenance of the information needed for planning and management of the area's ground-water resources.

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Table 4.--Records of selected wells in the Allegheny River basin and part of the Lake Erie basin, New York

EXPLANATION

For explanation of well number and location see section, "Numbering and Location System." All depths and altitudes are rounded to the nearest foot.

Well finish:

- F - Gravel wall, perforated or slotted casing
- G - Gravel wall, commercial screen
- O - Open end
- P - Perforated or slotted casing
- S - Screen
- T - Sand point
- W - Walled or shored
- X - Open hole in aquifer (generally cased to aquifer)

Water-bearing material:

- UNCLFD - Unclassified
- SED - Sediment
- UNCONSOL - Unconsolidated
- FRACT - Fractured
- JOINT - Jointed

Use:

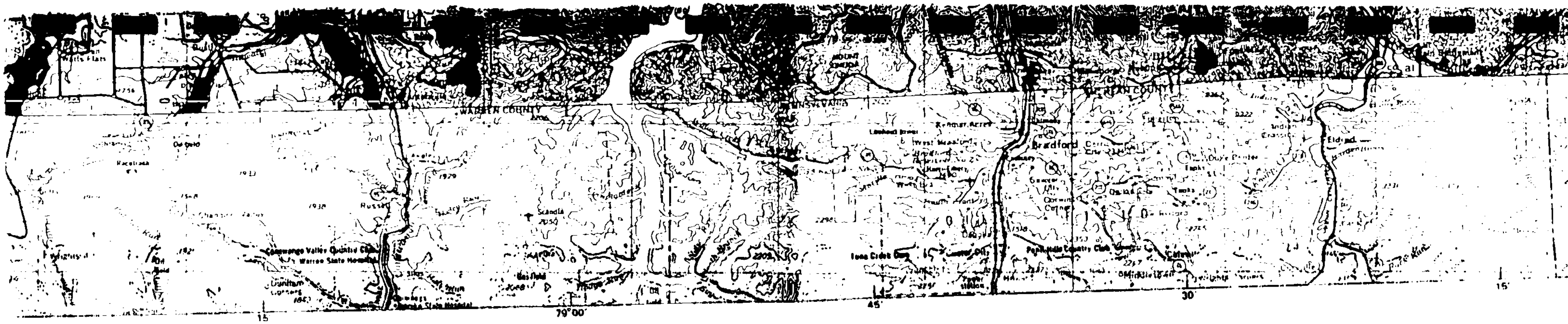
- A - Air conditioning
- B - Bottling
- C - Commercial
- F - Fire protection
- H - Domestic
- I - Irrigation
- N - Industrial
- P - Public supply
- S - Stock supply
- T - Institutional
- U - Unused
- Z - Other

Table 4.--Records of selected wells in the Allegheny River basin and part of the Lake Erie basin, New York (Continued)

WELL LOCATION (LAT.-LONG.)	OWNER	WELL DEPTH (FT)	CASING DIAMETER (IN)	WELL FINISH	CASING DEPTH (FT)	DEPTH TO CONSL. ROCK (FT)	WATER-BEARING MATERIAL	ALTITUDE (FT)	WATER LEVEL BELOW LAND SURFACE (FT)	DATE OF WATER-LEVEL MEAS.	YIELD (GPM)	USE
ALLEGANY COUNTY												
420004N0781647.1	HILL WALTER	135	--	P	--	--	SAND AND GRAVEL	1457	15	--	--	H
420012N0781440.1	WATERMAN DALE	32	6	P	--	--	SAND AND GRAVEL	1480	11	--	--	H
420023N0780657.1	OLMSTEAD RICHAR	90	6	X	85	85	SHALY OR SLATY SANDSTONE	1535	20	--	--	H
420033N0780402.1	WILSON	110	6	X	90	90	SHALY OR SLATY SANDSTONE	1547	30	--	--	H
420043N0780136.1	MADISON CLIFFOR	74	6	X	73	--	SAND AND GRAVEL	1587	34	--	--	H
420044N0780327.1	JOHNSON RUSSEL	80	6	O	80	100	SAND AND GRAVEL	1555	14	--	25	H
420116N0781321.1	KINNEY H A	335	7	X	265	--	SHALY OR SLATY SANDSTONE	1508	10	--	--	H
420128N0781330.1	HAZARD LYLE	106	6	X	--	48	SHALY OR SLATY SANDSTONE	1560	11	--	15	H
420227N0781133.1	MESSER OIL CORP	85	6	X	85	--	FINE SAND AND GRAVEL	1560	--	--	--	N
420235N0781144.1	MESSER OIL CORP	85	10	S	70	--	FINE SAND AND GRAVEL	1540	4	8-47	900	N
420240N0781142.1	MESSER OIL CORP	93	10	S	--	--	SAND AND GRAVEL	1540	--	--	900	N
420256N0781055.1	COWLES MAE	72	--	--	--	--	SAND AND GRAVEL	1600	--	--	--	H
420327N0781825.1	ESHELMAN CHARLE	97	6	X	77	--	SHALY OR SLATY SANDSTONE	1510	22	--	--	H
420346N0781020.1	BOLIVAR VILLAGE	110	--	S	--	--	SAND AND GRAVEL	1581	--	--	--	P
420346N0781022.1	BOLIVAR VILLAGE	120	--	--	--	--	SAND AND GRAVEL	1581	--	--	--	P
420347N0780914.1	PAYNE DAVE	252	6	X	--	--	SHALY OR SLATY SANDSTONE	1753	--	--	--	H
420349N0780917.1	CARR PAUL	232	7	X	--	--	SHALY OR SLATY SANDSTONE	1730	--	--	--	H
420409N0781647.1	DOTY RAY	20	36	W	0	--	SAND AND GRAVEL	1560	12	--	--	H
420431N0780436.1	MESSER OIL CORP	253	10	X	75	--	SHALY OR SLATY SANDSTONE	1900	33	12-39	100	N
420434N0780712.1	MAINS WILLIAM	140	--	--	--	--	SHALY OR SLATY SANDSTONE	1862	--	--	--	H
420438N0781734.1	BIXBY LOU	74	4	O	74	--	SAND AND GRAVEL	1537	9	--	--	H
420441N0780640.1	GRISWOLD SAMUEL	300	6	X	--	--	SHALY OR SLATY SANDSTONE	2095	--	--	--	H
420447N0781530.1	MESSER OIL CORP	227	10	X	134	--	SHALY OR SLATY SANDSTONE	1560	20	-39	56	H
420448N0780938.1	PUTNAM FRANK	300	4	X	--	--	SHALY OR SLATY SANDSTONE	1640	0	--	--	H
420509N0781550.1	MESSER OIL CORP	276	8	P	87	--	SHALY OR SLATY SANDSTONE	--	2	--	110	H
420534N0780914.1	MESSER OIL CORP	279	10	X	31	--	SHALY OR SLATY SANDSTONE	1660	5	8-42	125	N
420542N0781728.1	BOY SCOUTS AMER	65	6	O	65	--	FINE SAND AND GRAVEL	1680	F	--	7	I
420547N0781723.1	BOY SCOUTS AMER	262	5	X	204	--	SHALY OR SLATY SANDSTONE	1690	--	--	--	I
420610N0781507.1	SMITH KENNETH	120	6	X	115	--	SHALY OR SLATY SANDSTONE	1580	15	--	--	H
420640N0780756.1	FAULKNER JOHN	65	6	X	20	--	SHALY OR SLATY SANDSTONE	1861	30	--	--	H
420645N0781458.1	ANDRUSS JOHN	58	2	O	58	--	SAND AND GRAVEL	1582	27	--	--	H
420737N0781435.1	LOVE LEON H	110	6	P	104	--	SAND AND GRAVEL	1595	2	--	--	H
420743N0781433.1	HEWITT GENE	13	24	W	0	--	SAND AND GRAVEL	1595	8	9-67	--	H
421023N0781644.1	MARSH DEAN	40	1	T	40	--	SAND	1680	7	--	--	H
421123N0781553.1	BAKER BRIAN	50	2	X	24	24	SEDIMENTARY ROCK, UNCLED	1650	--	--	--	H
421156N0781631.1	CUBA CHEESE CO	52	4	X	24	24	SEDIMENTARY ROCK, UNCLED	1560	11	--	--	N
421201N0781632.1	CUBA VILLAGE	285	4	X	230	--	SHALY OR SLATY SANDSTONE	1562	--	--	100	U
421246N0781616.1	CUBA VILLAGE	59	12	S	49	--	SAND AND GRAVEL	1508	34	9-67	450	P
421314N0781658.1	CUBA VILLAGE	85	8	S	77	--	SAND AND GRAVEL	1482	--	--	300	P
421347N0781639.1	GURNSEY PRODUCT	28	6	O	28	--	UNCONSOL SED	1495	16	--	--	C
421436N0781623.1	HENDRIX GEORGE	94	6	O	94	--	UNCONSOL SED	1520	30	--	--	H
421444N0781534.1	BENJAMIN	29	5	O	29	--	UNCONSOL SED	1510	7	--	--	H
421534N0781802.1	TAYLOR ROY	60	6	O	60	--	UNCONSOL SED	1520	14	--	--	S
421838N0781826.1	OTTO HANNA	20	36	W	0	--	SAND AND GRAVEL	1630	10	--	--	U

Reference A-5

Cadwell, D.H., Surficial Geologic Map of New York - Niagara Sheet, 1988.



SURFICIAL GEOLOGIC MAP OF NEW YORK

NIAGARA SHEET

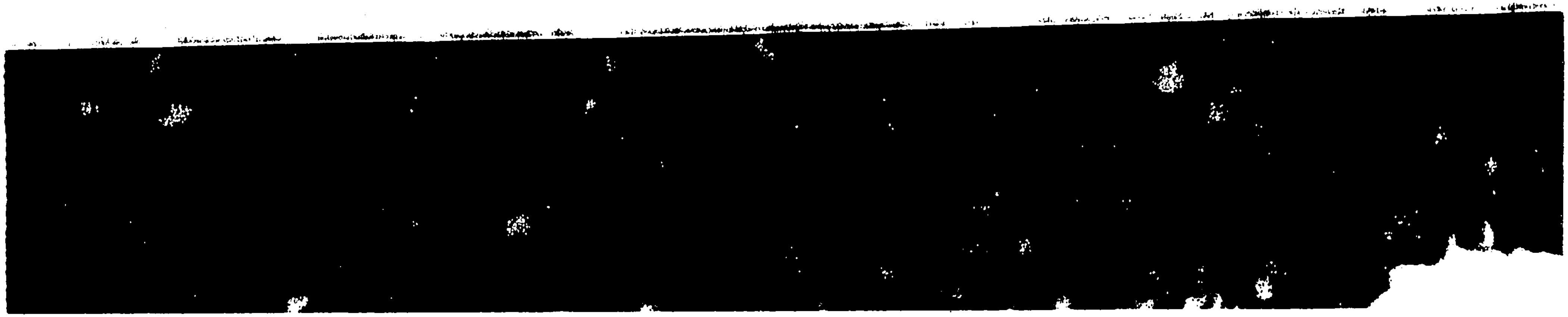
Compiled and Edited by Donald H. Cadwell

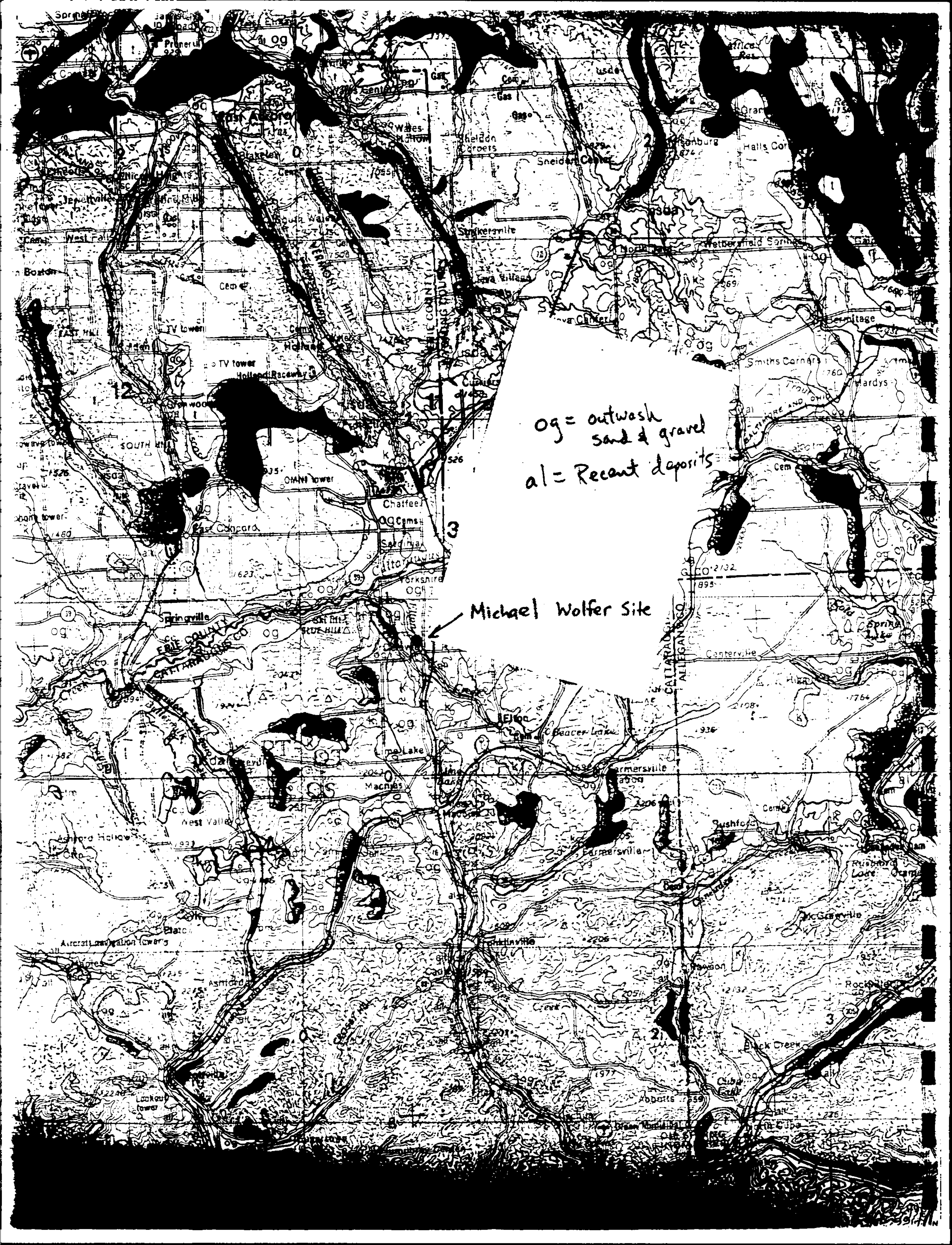
1988

Scale 1 250,000

CONTOUR INTERVAL 100 FEET

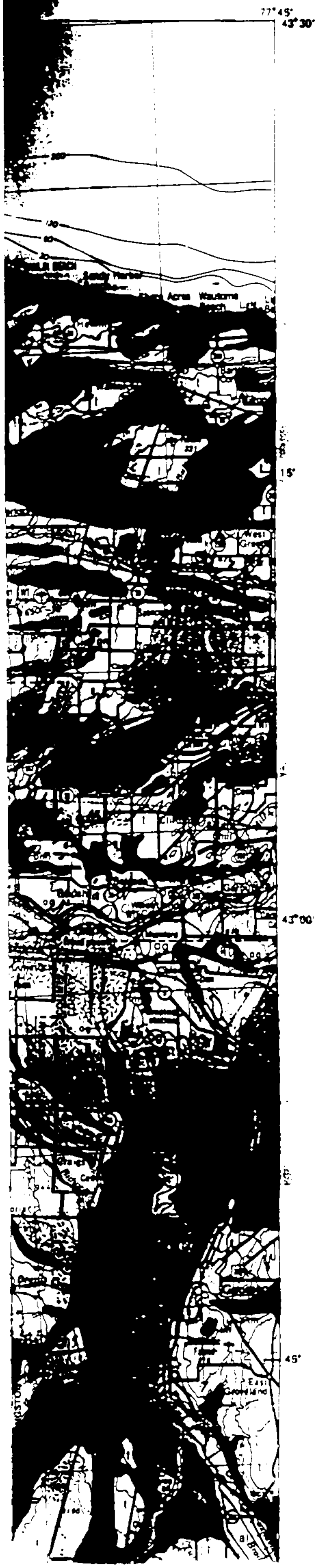
1948 MAGNETIC DECLINATION FOR THIS SHEET VARIES FROM ... CENTER OF THE WEST EDGE TO 13°00' WESTERLY FOR THE CE... MEAN ANNUAL CHANGE IS NEGLIGIBL...





og = outwash sand & gravel
al = Recent deposits
Michael Wolfer Site
Springville
ERIE COUNTY
CATTARAUGUS CO
East Concord
Chaffee
Yorkshire
Strykersville
Smiths Corners
Hermitage
Centerville
Farmersville
Machias
Rushford
Black Creek
Abbotts
Halls Cor
TV tower
OMNI tower
SOUTH HILL

ORK
NT



EXPLANATION

al — Recent deposits (al)
Generally confined to floodplains within a valley,
oxidized, non-calcareous, fine sand to gravel,
in larger valleys may be overlain by silt,
subject to frequent flooding, thickness 1-10 meters.

alf — Alluvial fan (alf)
Fan shaped accumulations,
poorly stratified silt, sand and boulders,
at the foot of steep slopes,
generally permeable.

co — Colluvium (co)
Mixture of sediments,
deposited by mass wasting,
thickness generally 1-5 meters.

cof — Colluvial fan (cof)
Fan shaped accumulation,
mixture of sediments,
at mouths of gullies,
thickness generally 1-5 meters.

cd — Colluvial diamicton (cd)
Mixture of sediments,
unique to region beyond Wisconsinan glacial limit,
rebedded saprolite and glacial debris,
may be old (Illinoian) drift,
homogenized by varying degrees of colluviation,
bedrock may sporadically crop out or be within 1-3 meters of the surface.

pm — Swamp deposits
Peat-muck, organic silt and sand in poorly drained areas,
un-oxidized,
may overlay marl and lake silts,
potential land instability,
thickness generally 2-20 meters.

lb — Lacustrine beach
Generally well sorted sand and gravel,
stratified, permeable and well drained,
deposited at a lake shoreline,
generally non-calcareous,
may have wave-winnowed lag gravel,
thickness variable (1-5 meters).

ld — Lacustrine delta
Coarse to fine gravel and sand,
stratified, generally well sorted,
deposited at a lake shoreline,
thickness variable (3-15 meters).

lsc — Lacustrine silt and clay
Generally laminated silt and clay,
deposited in proglacial lakes,
generally calcareous,
potential land instability,
thickness variable (up to 100 meters);
stipple overprint where bedrock is within 1-3 meters of the surface.

ls — Lacustrine sand
Sand deposits associated with large bodies of water,
generally a near-shore deposit or near a sand source,
well sorted, stratified,
generally quartz sand,
thickness variable (2-20 meters).

og — Outwash sand and gravel (og)
Coarse to fine gravel with sand,
proglacial fluvial deposition,
well rounded and stratified,
generally finer texture away from ice border,
may be calcreted beyond Wisconsinan glacial limit,
thickness variable (2-20 meters).

fg — Fluvial gravel (fg)
Same as outwash sand and gravel,
except deposition farther from glacier,
age uncertain.

k — Kame deposits
Includes kames, eskers, kame terraces, kame deltas,
coarse to fine gravel and/or sand,
deposition adjacent to ice (if at ice margin, relief is below elevation of associated outwash),
lateral variability in sorting, coarseness and thickness,
may be calcreted beyond Wisconsinan glacial limit,
thickness variable (10-30 meters).

usda — Undifferentiated stratified drift assemblage (usda)
Dominantly clay, silt and sand,
limited gravel and diamicton,
stratification includes undisturbed and deformed laminations,
ice contact structures,
lenticular, discontinuous bodies of gravel and flow till,
may represent dead-ice, disintegration and local ice-contact lake deposits in ice-marginal and subglacial environments,
thickness variable (3-30 meters).

km — Kame moraine
Variable texture (size and sorting) from boulders to sand,
deposition at an ice margin during deglaciation,
relief is above elevation of associated outwash.

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Site	Name, Town
1	Otto Otto
2	Clear Creek Collins
3	Nichols Bk Sardinia
4	Winter Gulf N. Collins
5	Lewiston Lewiston
6	Malloy Newfane
7	Houghton Bog Springville
8	Byron Byron
9	Sheridan Forestville
10	Marilla E. Aurora
11	Protection Arcade
12	Colden Colden
13	The Gulf Lockport
14	Sonyea Groveland
15	Macauley Site Geneseo

1. Blackmon,
thesis, Sta
2. Buckley, J
Radiocarbo
3. Calkin, P.E
York, Ohio
4. Crane, H.R
Supplemer
5. Hartnagel,
mete of Ne
6 Heubusch,
v 40, p.3-9
7 Hoflands, C
M.S. thesis

og — Outwash sand and gravel
Coarse to fine gravel with sand,
proglacial fluvial deposition,
well rounded and stratified,
generally finer texture away from ice border,
may be calcreted beyond Wisconsinan glacial limit,
thickness variable (2–20 meters).

fg — Fluvial gravel
Same as outwash sand and gravel,
except deposition farther from glacier,
age uncertain.

k — Kame deposits
Includes kames, eskers, kame terraces, kame deltas,
coarse to fine gravel and/or sand,
deposition adjacent to ice (if at ice margin, relief is below elevation of associated outwash),
lateral variability in sorting, coarseness and thickness,
may be calcreted beyond Wisconsinan glacial limit,
thickness variable (10–30 meters).

usda — Undifferentiated stratified drift assemblage
Dominantly clay, silt and sand,
limited gravel and diamicton,
stratification includes undisturbed and deformed laminations,
ice contact structures,
lenticular, discontinuous bodies of gravel and flow till,
may represent dead-ice, disintegration and local ice-contact lake deposits in ice-marginal and subglacial environments,
thickness variable (3–30 meters).

km — Kame moraine
Variable texture (size and sorting) from boulders to sand,
deposition at an ice margin during deglaciation,
relief is above elevation of associated outwash,
locally cemented with calcareous cement,
thickness variable (10–30 meters).

tm — Till moraine
More variably sorted than till,
generally more permeable than till,
deposition adjacent to ice,
more variably drained,
may include ablation till,
thickness variable (10–30 meters).

t — Till
Variable texture (e.g. clay, silt-clay, boulder clay),
usually poorly sorted diamict,
deposition beneath glacier ice,
relatively impermeable (loamy matrix),
variable clast content — ranging from abundant well-rounded diverse lithologies in valley tills to relatively angular, more limited lithologies in upland tills, tends to be sandy in areas underlain by gneiss or sandstone,
potential land instability on steep slopes,
thickness variable (1–50 meters).

r — Bedrock
Exposed or generally within 1 meter of the surface.

Bedrock stipple overprint
Bedrock may be within 1–3 meters of the surface,
may sporadically crop out,
variable mantle of rock debris and glacial till.

MAP SYMBOLS

Contact
Glacial meltwater channel
6 Dated radiocarbon locality
Esker

Principal Contributors: Donald H. Cadwell.

Reference A-6

Pearson, C.S., J.C. Bryant, and W. Secor, Soil Survey
Cattaraugus County, New York, USDA Bureau of Plant Industry,
Cornell University Agricultural Experiment Station, Ithaca, New York, 1940.

No. 12

Issued March 1940

Soil Survey

Cattaraugus County New York

By
C. S. PEARSON, in Charge
J. C. BRYANT and WILBER SECOR
Cornell University Agricultural Experiment Station
and
S. R. BACON, CLARENCE LOUNSBURY
W. J. CAMP, and C. B. BEADLES
United States Department of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PLANT INDUSTRY
In cooperation with the
Cornell University Agricultural Experiment Station

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vantage of an average frost-free season that is from 1 to 2 weeks longer than on the higher upland soils. Variations in texture and drainage, however, cause as wide a range in agricultural value of the soils of the lowlands as in the agricultural value of the soils of the uplands.

Even though the agriculture consists principally of dairying, the opportunity for diversification of crops is greater than in the uplands. In unfavorable seasons, as when rainfall is below normal, emergency crops can be grown with greater success than on any of the soils of the uplands. Transportation facilities also are superior on the soils of the lowlands. All these factors contribute to a more prosperous type of farming in the numerous valleys and lowlands, as compared with the uplands.

The soils of the lowlands occur on two main types of land forms: (1) Terraces, outwash plains, deltas, and lake plains; and (2) first bottoms and flood plains. Smaller subgroups are indicated on the basis of drainage conditions, as is done with the soils of the uplands.

WELL-DRAINED SOILS OF OLDER OUTWASH MATERIALS AND LAKE DEPOSITS

This subgroup includes members of the Chenango, Unadilla, Otisville, and Mentor series. The first three occupy terrace, or bench, positions and include some of the most highly prized soils of the county. The Chenango soils occur in all the larger valleys north of the section occupied by Dekalb soils. The Mentor soil, which is of minor extent, includes the steep faces of the terraces and certain hummocky areas of stratified drift with kettle-and-kame topography.

These soils are characterized by their grayish-brown friable surface soils and by the bedded sands and gravel of the lower subsoil layers and substrata. The Chenango and Otisville soils are gravelly, but the Unadilla soils are, for the most part, free from gravel. The latter are distinguished also by their bright-yellow or richer brown color, an inheritance from the Dekalb soils, from which they are washed. They are not so productive as the Chenango soils. With the exception of the Otisville soils, the soils of this group have very favorable relief for agriculture. Drainage is excellent, and cultivation can be carried on under a wide range of moisture conditions.

The sale of dairy products accounts for most of the income of farmers located on these soils. Such crops as hay, silage corn, and oats are the most important, but practically all of the alfalfa and considerable of the other specialized crops, including vegetables and small fruits, are produced on the Chenango soils. More than half of the total acreage of Unadilla soils is included in the Allegany Indian Reservation, where very little of the land is under cultivation. The few acres under lease to white farmers in the vicinity of Salamanca give evidence that the soils will produce well under proper management.

Chenango gravelly loam.—Chenango gravelly loam has an 8-inch surface layer of brown or grayish-brown loose mellow gravelly loam. The subsurface material, to a depth of 20 inches, is brownish-yellow or grayish-yellow firm silt loam or gravelly silt loam. Below this in many places is a slightly compact layer composed of dark-brown mixed sand and gravel loosely cemented by an infiltration of silt

from 2 to 3 feet into the sand and gravel substratum that underlies the soil, which, at a depth ranging from 3 to 4 feet, generally is bedded or stratified.

This soil as a whole is fairly uniform. Slight variations in texture, thickness of horizons, and quantity of gravel in the surface horizon, however, do occur. The gravel consists mostly of water-worn rounded material, derived mainly from local shales and sandstone, with variable quantities of foreign crystalline materials, and nowhere is it so abundant as to interfere seriously with the preparation of the seedbed. The soil is rather strongly acid in the surface soil and subsoil, but a few limestone pebbles are present in many places at a depth ranging from 6 to 8 feet.

The most extensive areas of Chenango gravelly loam are along Cattaraugus Creek, especially near Gowanda and north of Delevan, and along Slab City Creek in Dayton Town. The total area of this soil is 31 square miles.

The land is level or slightly undulating, and this relief is characteristic of deposits, laid down by water as stream terraces, outwash plains, and deltas, that represent the parent material of the Chenango soils. Drainage is excellent and may be excessive in areas where the gravel content is high.

Acre yields of the main crops grown on Chenango gravelly loam are: Timothy and clover, from 1½ to 2 tons; oats, 40 bushels; silage corn, 8 to 10 tons; and alfalfa, 2 to 3 tons. The soil is physically well adapted to the production of alfalfa, but, because of its acid reaction, some form of lime is necessary for success. The soil warms early in the spring and can be worked almost as soon as the frost leaves the ground—reasons that make this a good soil for the production of potatoes, vegetables, and canning crops. The acreage of such crops, although low at present, is increasing annually. There is a canning factory at South Dayton, and some of the produce is trucked to canneries in Erie County.

The most common rotation is corn, oats, and hay for 2 or 3 years or longer if alfalfa is substituted for the usual timothy and medium red clover. Phosphate fertilizer is applied to land for corn and oats and lime to that for the new alfalfa seedings. Complete fertilizers are used to some extent on the specialized crops.

Practically all the land is under cultivation, with 50 percent of the area devoted to hay, 10 percent to oats, 10 percent to corn, 5 percent to pasture, and the rest to such crops as grapes, other small fruits, and vegetables.

Chenango gravelly silt loam.—Chenango gravelly silt loam, as the name signifies, has a heavier textured surface layer than the gravelly loam. The distinction between these two soils, however, is not very marked, and wherever they are associated the boundary drawn between them is more or less arbitrary. The profiles, aside from the texture of the surface layers, are identical, as are the mode of deposition of the parent material, relief, and reaction. The brown or gray-brown surface layer and the yellowish-brown silty subsurface layer, which overlies bedded sand and gravel, are characteristic of Chenango soils in general.

This soil has its most typical and extensive development in the

Reference A-7

Rickard and Fisher, Geologic Map of New York - Niagara Sheet, 1970.

GEOLOGIC MAP OF NEW YORK

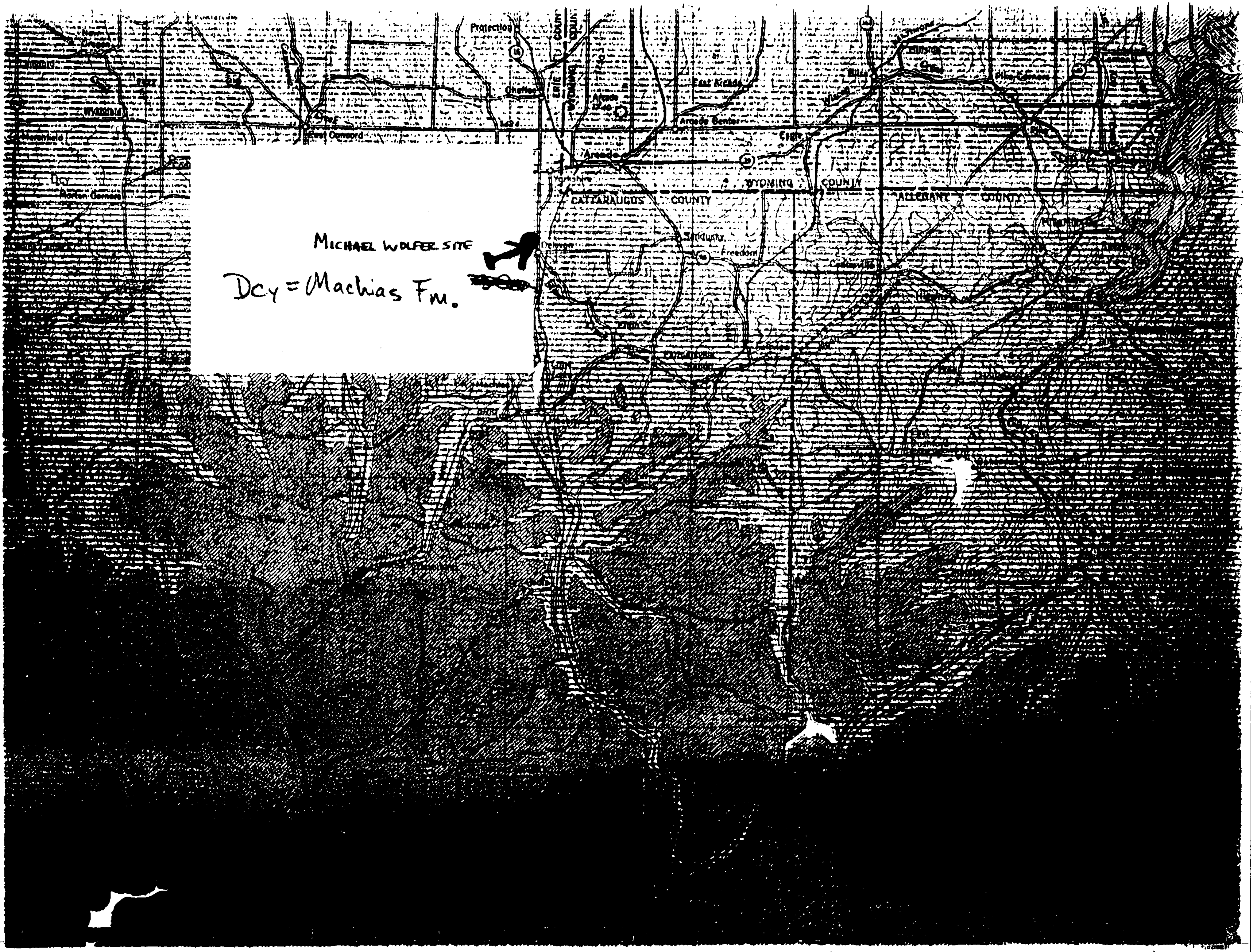
1970

Niagara Sheet

COMPILED AND EDITED BY

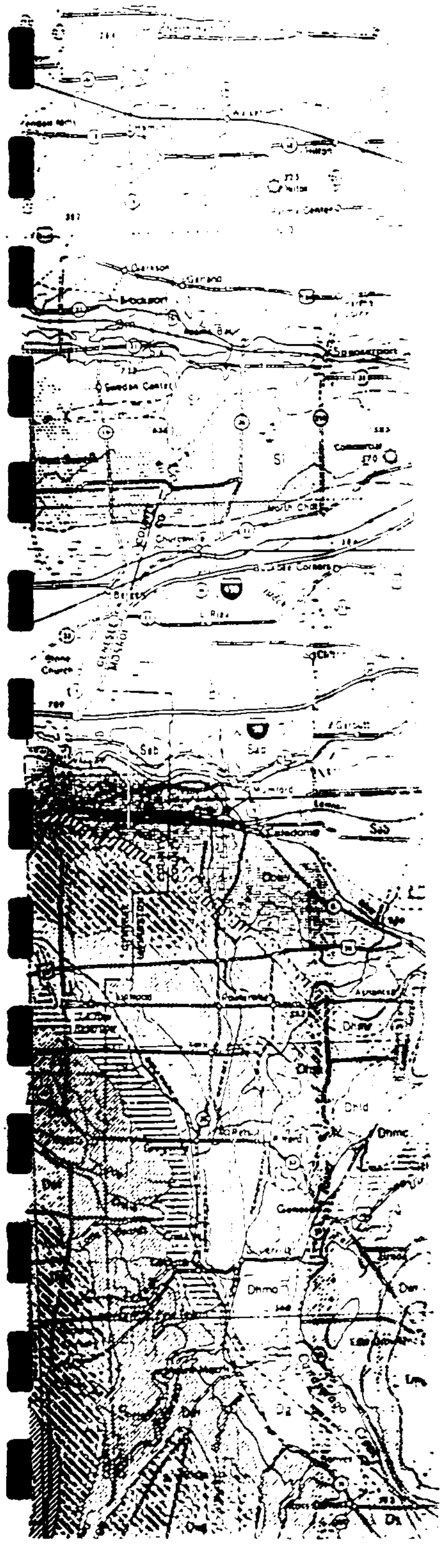
Lawrence V. Rickard
Donald W. Fisher

March, 1970



MICHAEL WOLFER SITE
Dcy = Machias Fm.
Protection
Chaffee
East Arcade
Arcade Center
Arcade
Yorkshire
WYOMING COUNTY
CATTARAUGUS COUNTY
ALLEGANY COUNTY
Sandusky
Freedom
Delevan
East Concord

GEOLOGICAL SURVEY
James F. Davis, State Geologist



LEGEND

NOTE: Where the uniformity of lithology and availability of pattern combinations permit, the dominant lithology of a mapping unit is symbolized as follows:

Cross-hatch patterns:
- rhombic grid—dolostones
- rectangular grid—limestones

Line patterns:
- straight—pelitic rocks: shales, shales interbedded with siltstones and sandstones

Stipple patterns:
- regular red—quartz sandstones and quartzites
- random red—non-marine sedimentary rocks

An irregular lower margin on the "color boxes" signifies that the unit has an unconformable relationship with subjacent units, however not necessarily with the next unit listed. Wavy lines signify parallel unconformities, sawtooth lines signify angular unconformities.

PALEOZOIC

Lower Pennsylvanian

Pp

POTTSVILLE GROUP
Connoquenessing Formation—sandstone, shale; Sharon Formation—shale, sandstone, conglomerate; Olean Conglomerate 50-100 ft. (15-30 m.)

Lower Mississippian

Mp

POCONO GROUP
Cuyahoga Formation—shale, sandstone; Corry Sandstone; Knapp Formation 60-100 ft. (20-30 m.)—shale, conglomerate.

Upper Devonian

CONEWANGO GROUP
450-650 ft. (140-200 m.)
Oswayo and Venango Formations—shale, siltstone, sandstone; replaced eastwardly by Cattaraugus Formation—shale, sandstone, conglomerate.

CONNEAUT GROUP
250-600 ft. (75-200 m.)
In west, Ellicott and Dexterville Formations—shale, siltstone.
In east, Germania Formation—shale, sandstone; Whitesville Formation—shale, sandstone; Hinsdale Sandstone; Wellsville Formation—shale, sandstone; Cuba Sandstone.

Dcvs Dckl Dcd

CANADAWAY GROUP
700-1200 ft. (210-370 m.)
Northeast Shale; Shumla Siltstone.
Westfield Shale, Laona Siltstone.
Gowanda, South Wales, and Dunkirk Shales.
Machias Formation—shale, siltstone; Rushford Sandstone; Caneadea, Canisteo, and Hume Shales; Canaseraga Sandstone; South Wales and Dunkirk Shales.

Dj

JAVA GROUP
100-200 ft. (30-60 m.)
Hanover Shale; Wiscoy Formation—sandstone, shale; Pipe Creek Shale.

Dwf Dwn Dwg Dwr

WEST FALLS GROUP
400-950 ft. (120-290 m.)
Angola and Rhinestreet Shales
Nunda Formation—sandstone, shale
West Hill and Gardeau Formations—shale, siltstone; Roricks Glen Shale, upper Beers Hill Shale; Grimes Siltstone
lower Beers Hill Shale, Dunn Hill, Millport, and Moreland Shales

Ds

SONYEA GROUP
50-200 ft. (15-60 m.)
Cashaqua and Middlesex Shales

Dg

GENESEE GROUP
10-150 ft. (3-45 m.)
West River Shale, Genundewa Limestone, Penn Yan and Geneseo Shales; North Evans Limestone

Middle Devonian

Dhmo Dhld Dhsk Dhmr

HAMILTON GROUP
200-500 ft. (60-150 m.)
Moscow Formation—Windom and Kashong Shales, Menteth Limestone Members
Ludlowville Formation—Deep Run Shale, Tichenor Limestone, Wanakah and Ledyard Shales, Centerfield Limestone Members
Skaneateles Formation—Levanna Shale, Stafford Limestone Members
Marcellus Formation—Oatka Creek Shale Member

Doo

ONONDAGA AND BOIS BLANC LIMESTONES
150 ft. (45 m.)
In New York, Onondaga Limestone—Seneca, Moorehouse (cherty) and Clarence Limestone Members, Edgecliff cherty Limestone Member, local coral bioherms; Bois Blanc Limestone—sandy, thin, discontinuous.
In Ontario, Dundee Limestone; Lucas Formation—dolostone, limestone (Anderdon); Amherstburg F...

Reference A-8

Lenz and Riecker, State of New York Official Compilation of Codes, Rules and Regulations, Title 6 NYCRR Conservation, published for the Department of State, 1967.

STATE OF NEW YORK

OFFICIAL COMPILATION

OF

CODES, RULES AND REGULATIONS

MARIO M. CUOMO
Governor

GAIL S. SHAFFER
Secretary of State

Published by
DEPARTMENT OF STATE
162 Washington Avenue
Albany, New York 12231

TABLE I (*cont'd*)

Item No.	Waters Index Number	Name	Description	Map Ref. No.	Class	Standards
115	E 23-48 portion	Elton Creek	From trib. 3 to trib. 6	L-6	C	C(T)
116	E 23-48 portion	Elton Creek	From trib. 6 to trib. 15.	L-6	C	C(T)
117	E 23-48 portion	Elton Creek	From trib. 15 to source.	L-6	C	C(T)
118	E 23-28-1	Stony Creek	From mouth to source.	K-5 L-5	C	C(TS)
119	E 23-48-1-1, 2 3	Tributaries of Stony Creek		K-5	D	D
120	E 23-48-2 portion	Tributary of Elton Creek	Mouth to trib. 1.	K-6	C	C(T)
121	E 23-48-2 portion	Tributary of Elton Creek	From trib. 1 to source.	K-6 L-6	D	D
122	E 23-48-2-1 portion	Tributary of tributary of Elton Creek	Mouth to point 0.7 mile upstream from mouth.	K-6	C	C(T)
123	E 23-48-2-1	Tributary of tributary of Elton Creek	From 0.7 mile upstream from mouth to source.	K-6	D	D
124	E 23-48-2-1-1	Tributary of tributary of tributary of Elton Creek		K-6	D	D
125	E 23-48-2-2 and tribs., 3	Tributary of trib. 2 of Elton Creek		L-6	D	D
126	E 23-48-3 portion including P 127	Lime Lake Outlet	Mouth to P 127.	L-6	C	C(TS)
127	E 23-48-3	Lime Lake Outlet	From P 127 to P 130 (Lime Lake).	L-6	C	C(TS)
128	E 23-48-3-1	Tributary of Lime Lake Outlet		L-6	C	C(T)
129	E 23-48-3-1-1	Tributary of trib. 1 of Lime Lake Outlet		L-6	D	
130	E 23-48-3-2	McKinstry Creek		L-5		
131	E 23-48-3-2-1a	Tributary of McKinstry Creek				
132	E 23-48-3-2-1 and tribs.	Tributary of McKinstry Creek				(TS)

§ 838.6

Item No.	Waters Index Number	Name	Description	Map Ref. No.	Class	Standards
		Elton Creek	From trib. 6 to trib. 15.	L-6	C	C(T)
117	E 23-48 portion	Elton Creek	From trib. 15 to source.	L-6	C	C(T)
118	E 23-28-1	Stony Creek	From mouth to source.	K-5 L-5	C	C(TS)
119	E 23-48-1-1, 2 3	Tributaries of Stony Creek		K-5	D	D
120	E 23-48-2 portion	Tributary of Elton Creek	Mouth to trib. 1.	K-6	C	C(T)
121	E 23-48-2 portion	Tributary of Elton Creek	From trib. 1 to source.	K-6 L-6	D	D
122	E 23-48-2-1 portion	Tributary of tributary of Elton Creek	Mouth to point 0.7 mile upstream from mouth.	K-6	C	C(T)
123	E 23-48-2-1	Tributary of tributary of Elton Creek	From 0.7 mile upstream from mouth to source.	K-6	D	D
124	E 23-48-2-1-1	Tributary of tributary of tributary of Elton Creek		K-6	D	D

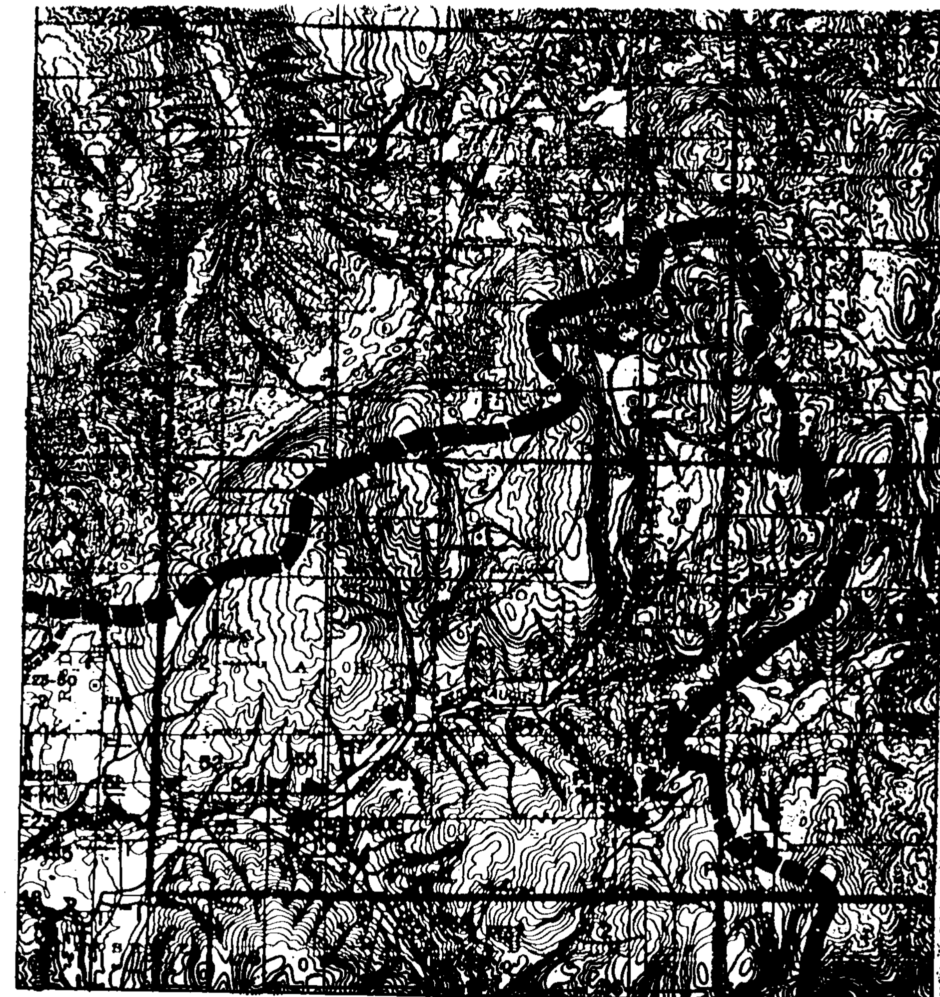
TABLE I *(cont'd)*

Item No.	Waters Index Number	Name	Description	Map Ref. No.	Class	Standards
125	E 23-48-2-2 and tribs., 3	Tributary of trib. 2 of Elton Creek		L-6	D	D
126	E 23-48-3 portion including P 127	Lime Lake Outlet	Mouth to P 127.	L-6	C	C(TS)
127	E 23-48-3	Lime Lake Outlet	From P 127 to P 130 (Lime Lake).	L-6	C	C(TS)
128	E 23-48-3-1	Tributary of Lime Lake Outlet		L-6	C	C(T)
129	E 23-48-3-1-1	Tributary of trib. 1 of Lime Lake Outlet		L-6	D	D
130	E 23-48-3-2	McKinstry Creek		L-5 L-6	C	C(TS)
131	E 23-48-3-2-1a	Tributary of McKinstry Creek		L-6	D	D
132	E 23-48-3-2-1 and tribs.	Tributary of McKinstry Creek		L-5 L-6	C	C(T)
133	E 23-48-3-2-2, 3, 4	Tributaries of McKinstry Creek		L-5	C	C(T)
134	E 23-48-3-P 128, P129	Unnamed ponds		L-6	D	D

Item No.	Waters Index Number	Name	Description	Map Ref. No.	Class	Standard
100	E 23-32-P 117	Unnamed pond		K-5sw	D	
101	E 23-32-3 and tribs.	Tributary of Spring Brook		K-5sw	D	D
102	E 23-32-P 118	East Concord Pond		K-5sw	C	
103	E 23-32-4 including P 118a through P 118c	Tributary of Spring Brook		K-5sw	D	D
104	E 23-32-P 118d through P 118h	Unnamed ponds		K-5sw	D	
105	E 23-33 portion	Buttermilk Creek	Mouth to tributary 7	L-5	D	D
105.1	E-23-33 portion	Buttermilk Creek	From tributary 7 upstream 1.0 mile	L-5	C	
105.2	E-23-33 portion	Buttermilk Creek	From 1.0 mile upstream of trib. 7 to source	L-5	D	D
106	E 23-33-1 and tribs., 2 and tribs., 3, 4 and tribs., 6 and tribs., 6a	Tributaries of Buttermilk Creek		L-5	D	
106.1	E-23-33-5	Gooseneck Creek	Mouth to source	L-5	C	
106.2	E-23-33-5-1,2 and tribs., 3	Tribs. of Gooseneck Creek		L-5	D	
107	E 23-33-7 and tribs.	Indian Creek		L-5	C	C(T

TABLE I *(cont'd)*

Item No.	Waters Index Number	Name	Description	Map Ref. No.	Class	Standard
108	E 23-P 118i	Unnamed pond		K-5sw	D	D
109	E 23-34	Stony Brook		L-5	D	D
110	E-23-34a	Tributary of Cattaraugus Creek	Mouth to source (P123)	L-5 K-5sw	C	C([illegible])
110.1	E-23-34a-P119, P119a, P119b, P 119c, P 121, P122	Unnamed Ponds		K-5sw	D	D
111	E 23-34-P 123	Peterson's Pond		K-5sw	B	B
112	E 23-34a-P 124, P 125, P 125a, P 125b, P 126	Unnamed group of ponds		K-5sw	D	D
113	E 23-35 and tribs., including P 126a through P 126k, 36 and tribs., 37 and tribs., including P 126L through P 126n, 38, 38a, 39, 40, 41, 42, 43, 44 and tribs., 45, 46, 47	Tributaries of Cattaraugus Creek		K-5 L-5 K-5sw	D	D
114	E 23-48 portion	Elton Creek	Mouth to trib. 3.	K-5 K-6 L-6	C	C(TS



1698 CN 10-15-66

FRANKLINVILLE

SCALE IN MILES
1 1/2 0 1

MAP L-6

1702 CN 10-15-66

Reference A-9

Ecology and Environment Engineering, P.C., Phase I Investigation, Michael Wolfer, Site Number 905020, Village of Delevan, Cattaraugus County, February 1990.

ND-2900 D1667

ENGINEERING INVESTIGATIONS AT INACTIVE HAZARDOUS WASTE SITES

PHASE I INVESTIGATION

MICHAEL WOLFER, SITE NUMBER 905020
VILLAGE OF DELEVAN, CATTARAUGUS COUNTY

February 1990

Prepared for:

New York State Department of Environmental Conservation

50 Wolf Road, Albany, New York 12233
Thomas C. Jorling, Commissioner

Division of Hazardous Waste Remediation
Michael J. O'Toole, Jr., P.E., Director

Prepared by:

Ecology and Environment Engineering, P.C.

Reference A-10

Background Soil Elemental Concentrations (a compilation from cited literature).

Background Soil Elemental Concentrations
(ppm)

Constituent	N.Y.S	Albany	U.S.	Other	Citation
ALUMINUM	-	1,000 - 25,000	-	7,000 - 100,000a	4/15, 15
ANTIMONY			8.80		15
ARSENIC	3 - 12	0.1 - 6.5	<0.l - 45	<0.1 - 73	19
					1/3/9/11/18/20/21,
					15, 15
BARIUM	15 - 600	250 - 350	10 - 3,000	10 - 1,500	15/16, 15, 18,7
BERYLLIUM	0 - 1.75	0 - 0.9	-	< 1 - 7a	15/16, 15/16, 15
CADMIUM	1.80	-	0.05 - 2.4	0.0001 - 1.0	8, NC
					8/10/11/13/17
CALCIUM	130 - 35,000	150 - 6,500	-	100 - 280,000	15, 15/16, 16
CHROMIUM	1.5 - 40	1.5 - 25	2 - 270	0.1 - 1,000e/a	4, 4/15, 15, 2/15
COBALT	2.5 - 6	2.5 - 6	0.1 - 2.4	<0.3 - 70a	4/15, 3/11, 18, 15
COPPER	-	<1 -15	1 - 57	<1 - 700a	4/15, 17/12, 15
IRON	-	2,500 - 17,500	-	100 - 100,000a	4/15, 15
LEAD	30	1 - 12.5	4 - 61	<10 - 300a	8, 4/15, 9, 15
MAGNESIUM	-	1,700 - 6,000	-	50 - 50,000a	15/4, 15
MANGANESE	5 - 5,000	400 - 600	-	<2 - 7,000a	4/15, 4/15, 15
MERCURY	-	0.042 - 0.066	-	0.01 - 3.4a	15, 15
NICKEL	0.5 - 25	6 - 12.5	0.5 - 23	<5 - 700a	4, 4/15, 1, 15
POTASSIUM	47.5 - 43,000	12,500 - 17,500	10,000 - 20,000	50 - 37,000a	6/15, 14/15, 5, 15
SELENIUM		<0.l - 0.1 25	-	0.1 - 5.lc	15, 7/15
SODIUM	-	6,000 - 8,000	-	150 - 50,000b	15, 4/15
VANADIUM	-	25 - 60	2 - 270	1 - 300	NC, 18, 4/15
ZINC	-	-	-	<5 - 2,900	15

Key -. NC- no citation available; a- Eastern US; b-New Jersey; c-Massachusetts: d-Pennsyivania e-Vermont-, f- New Hampshire

Key to Citations: Commas separate citations for each of the 4 data columns. The numbered citations appear on the following pages.

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SECTION 2

CITED DOCUMENTS

List of Cited Documents

Document B-1

Cattaraugus County Department of Health Correspondence

Jack McMahon, DEC - BRO   October 3, 1978

Chester Halgas

Motorola Industrial Waste Disposal

The following is a report on our activities concerning the subject waste from the Motorola plant in Arcade which found its way to various locations in north-eastern Cattaraugus County.

On September 19, 1978, Mr. Dan Pascarella of our office observed 97 drums on the old Machias Town sanitary landfill site. He investigated the matter and wrote the attached report which was referred to Kevin Hintz of your Department. On or about September 25th, Mr. Reisner of this office brought to my attention that more drums were in the area. I then contacted Mr. George Wyllie, chief industrial engineer at Motorola, to more specifically determine the nature of the wastes.

Through subsequent field investigations by Messrs. Pascarella and Reisner, it was determined by September 29, 1978, that approximately 2500 drums of industrial waste from Motorola had been placed in Cattaraugus County by three unregistered waste haulers at the following locations.

Prior to May of 1976, apparently all of the wastes had been hauled by Community Disposal Services to their landfill in Erie County. At that time, they went out of business and waste was then hauled by William Ballard, Osmon Road, Freedom Town, Cattaraugus County (492-2113) from May 1976 to May of 1977. During that time, he took approximately 1,000 drums which were given to the Previty Auto Wrecking yard on Galen Hill Road, Freedom Town, which is located approximately ½ mile south from the intersection with Route #98. All of these drums had been emptied by Mr. Previty on his property. He has a private well for his house and business on the property. No other water supplies are in the immediate area, and it is doubtful if any appreciable amount of waste found its way into Clear Creek, a protected trout stream, approximately ½ mile to the north of the dumping site. Reportedly, the waste materials were used to oil roads, and the drums were used to support junk cars.

From May 1977 to March 1978, approximately 1,000 drums were taken by a Donald Tillinghast, 18 Yacht Club Drive, Machias (353-8826) to the following locations: From May to winter, approximately 600-800 drums were deposited at Tidds Junkyard on County Road #72, several hundred yards west of the Big N Plaza at Yorkshire Corners. Mr. Tidds reported that he gave away approximately 100 of these drums which are unaccounted for except for 20 which went to Michael Wolfer in Delevan. Approximately 50% of the drums at Tidds Junkyard had been spilled or opened and a considerable amount of spillage exists on the property. Nearby residences and businesses are served by the Yorkshire Town public water supply, and there appears to be no threat from a water supply standpoint. The site of the drums is very flat and it is doubtful if appreciable amounts of the waste got into Cattaraugus Creek which is approximately ½ mile away. Apparently the winter weather precluded dumping of the drums at Tidds Junkyard and reportedly Mr. Tillinghast gave 20 drums to Camp Arrowhead on Route #16, Yorkshire Town, which were later buried. He also gave approximately 100 drums to Norman Rogers who used them for fill on his property, approximately ½ mile east of the Village of Delevan on California Road. 13 drums were given to Terwilliger Excavation in Franklinville which are still intact, and 13 drums were dumped on the Boehmer property on Route #16, Machias, directly across and approximately 225' distant from the new Town of Machias and County Infirmary well. At the Boehmer site, more than half of the drums had been spilled. It is further reported that some unknown quantity of drums were dumped and covered in a ravine on the south side of Route #242 just west of its junction with Route #16. In addition, 97 drums had been dumped at the aforementioned Machias landfill site, which is no longer in operation there. A number of the drums had been spilled and significant amount of spilled wastes are on the site. Fortunately, except for the 2 water wells mentioned above, no other water supplies appear to be possibly affected, and the aforementioned spillages are not in locations where appreciable overland flow of the wastes to streams would occur.

From March 1978 to the end of September when Motorola discontinued allowing private haulers to take these wastes, approximately 600 drums were taken by a Dan Griswold, Reynolds Road, Franklinville (676-2403) to the Town of Machias gravel pit on Very Road, located approximately one mile south of the intersection of Very Road and County Road #16, which is slightly more than two miles directly west of the hamlet of Machias. At this location, approximately one-half of the drums had been emptied, and it is reported that the Town of Machias used these waste materials in oiling some of the Town roads. However, we have been unable to verify this report, and the Town Supervisor has stated that she knew nothing of the storage or the use of this material.

On Thursday, September 28th, the writer toured several of the sites with Messrs. Vought and Wyllie of Motorola and Mr. Reisner of this office. The Motorola representatives indicated that most, if not all, of the drums came from their plant. The drums are mainly identified by the product that they contained when they were shipped to Motorola and are largely characterized by the names of the chemical, e.g. Magnoli Chemical, chlorothane, freon, etc. The newer drums have waste labels affixed to them by Motorola.

Motorola uses the following products which may in some part be discarded as industrial waste: Machining oils (Hamidraw D21-HV, GM Industries Limited 991, and HM 1301 DC), epoxies, epoxy solvent (Dibutylphthalate), flux, flux thinner (Alpha Metals 810), degreasers, polyurethane varnishes, Tolune, Xylene, Freon, dilute hydrochloric acid, metal grindings and metal. Motorola is to prepare a report stating the relative amounts of these products which may find their way into the industrial waste.

Investigation with suppliers and manufacturers revealed that many of the products are proprietary and that the exact content was not revealed to Motorola. The contents as reported by the suppliers and manufacturers are:

Hamidraw D21-HV - Harry Miller Corp., Philadelphia, PA (215-324-4000). Sulfanated petroleum oil 19.6% by weight; petroleum oil, 19.4%; chlorinated petroleum wax, 4.5%; lead tallate solution, 19.7% (75% kerosene and 25% lead tallate. % lead in lead tallate is 42%); Butyl Carbitol, 3% (the solution has a pH of 9.5 and the manufacturer advises handling with care. D21-HV is used in its undiluted form and also a 50% dilution with water at Motorola.

HM 1301 DC is also made by Harry Miller Corp. and contains: Mineral oil, 65%; sodium petroleum sulfonate, 14%; lead tallate, 19%; ethyloxylated alcohol, 2%.

The epoxy formulations used were obtained from a previous supplier, Hysol of Olean, New York, who reports that the epoxy resin is approximately a 400 molecular weight diglycidyl ether of bisphenol A plus 5% cresyl glycidyl ether. The hardener is a polyoxypropylene diamine.

The machine oil 991 supplied by GM Industries Limited in Tonawanda (693-6050) consists of the following: Tall oil, 10%; polysperm oil, 3%; sodium petroleum sulfonates, 7%; stearic acid, .3%; triethanolamine, 4.5%; hexylene glycol, 4%; Union Carbide U con LB 65, 2% (a proprietary compound which is a poly alkaline glycol); plan oil, .5%; emulsifier, .5%, chlorinated paraffin wax, 2%; petroleum oil, 15%; tetrasodium EDTA, .75%; biocide solution, 1.4% (solution of 18.5% 2' dihydroxy; 5' 5' dichloro-diphenyl methane, 6.7% of 50% sodium hydroxide and the rest water); Blue dye, .015%; water, 45.5%.

The flux is Alpha Metals, New Jersey (201-434-6778) and consists of a gum resin, an organic activator and a terpine alcohol solvent blend. The flux thinner is Alpha Metals 810 and a blend of alcohol and terpine solvent. No one was available who could give an exact formulation.

The degreasers used are trichloroethene and trichloroethylene.

The waste also contains metal grindings and machining wastes together with paper cups and rags, presumably from the epoxy casting process.

A literature review of the toxicity of the above chemicals indicates that practically all of them are mildly to moderately toxic, except for the biocide and lead. Fortunately, most of the spillage has occurred in environmentally insensitive areas except for the possible involvement of two water supplies. This Department plans to sample these two supplies together with any others that may be reasonably close to the two spillages, and have the samples analyzed for lead. It is the writer's opinion that lead will travel to the ground waters more quickly than any of the other chemicals and that it would therefore be a good indicator chemical.

In the writer's opinion, the spillages present a moderate environmental hazard that at this time, aside from the possible aforementioned affect on water supplies, poses no public health problem because of the remoteness and nature of the sites. The question of what to do with the spillages is therefore more properly the responsibility of the Department of Environmental Conservation, as is the matter of the three unregistered industrial waste haulers.

There are approximately 800 intact drums of Motorola's industrial waste at the aforementioned sites. Because of their nature and the potential deleterious environmental effects, they should be moved to a satisfactory disposal area. In this regard, this office has requested Motorola to move the intact drums. It is anticipated that they will be making a decision in the very near future.

Although ignorance of the exact nature of these chemicals is not a good excuse, it must be pointed out that in the opinion of the writer, neither Motorola nor the three haulers had any good indication as to the wastes' actual content.

CRH:PM
Attachment
CC: Machias Office
William Bruyere, Plant Manager, Motorola

Document B-2

New York State Department of Environmental Conservation Correspondence

Memo: Jaspal Walia
DEC
600 Delaware Ave
Buffalo, NY 14202

Date: 02/24/88

cc: Linda Rusin
SHD
584 Delaware Avenue
Buffalo,NY 14202

CCHD, Olean Office

RE: Review of Motorola Sites in Cattaraugus Cty.

The Department recommends that water supplies on, and adjacent to, all sites be to sampled appropriately for Part 5 constituents and 502.1. After review of the sampling results, a determination should be made regarding future sampling frequency and constituents to be analyzed. If the State Health Department can make available laboratory facilities to do the testing, we can provide the sampling contingent on work load.

Site maps are enclosed with the approximate location of wells which should be sampled.

Following are specific comments on each site:

Terwilliger:

The barrels should be removed from the site.

Route 242:

We have the results of the 502.1 collected on 11/30/87. Results show no contaminant levels of concern.

Boehmer Site:

Location of Machias Municipal and on site private well should be included in report. This site is not in the Allegheny River Basin.

Machias Landfill:

Report should show area which is served by private wells and municipal water. This site is probably on a ground water divide. More work is needed to determine which way the ground water flows. This could vary depending on the time of the year.

Rogers Site:

This site is not in the Allegheny River Basin. Mention is made of the Elton Farm Dump, shouldn't this site be located and investigated?

Wolfer Site:

The Delevan Springs are upstream and draw from an aquifer far removed from this site. The site is not in the Allegheny River Basin.

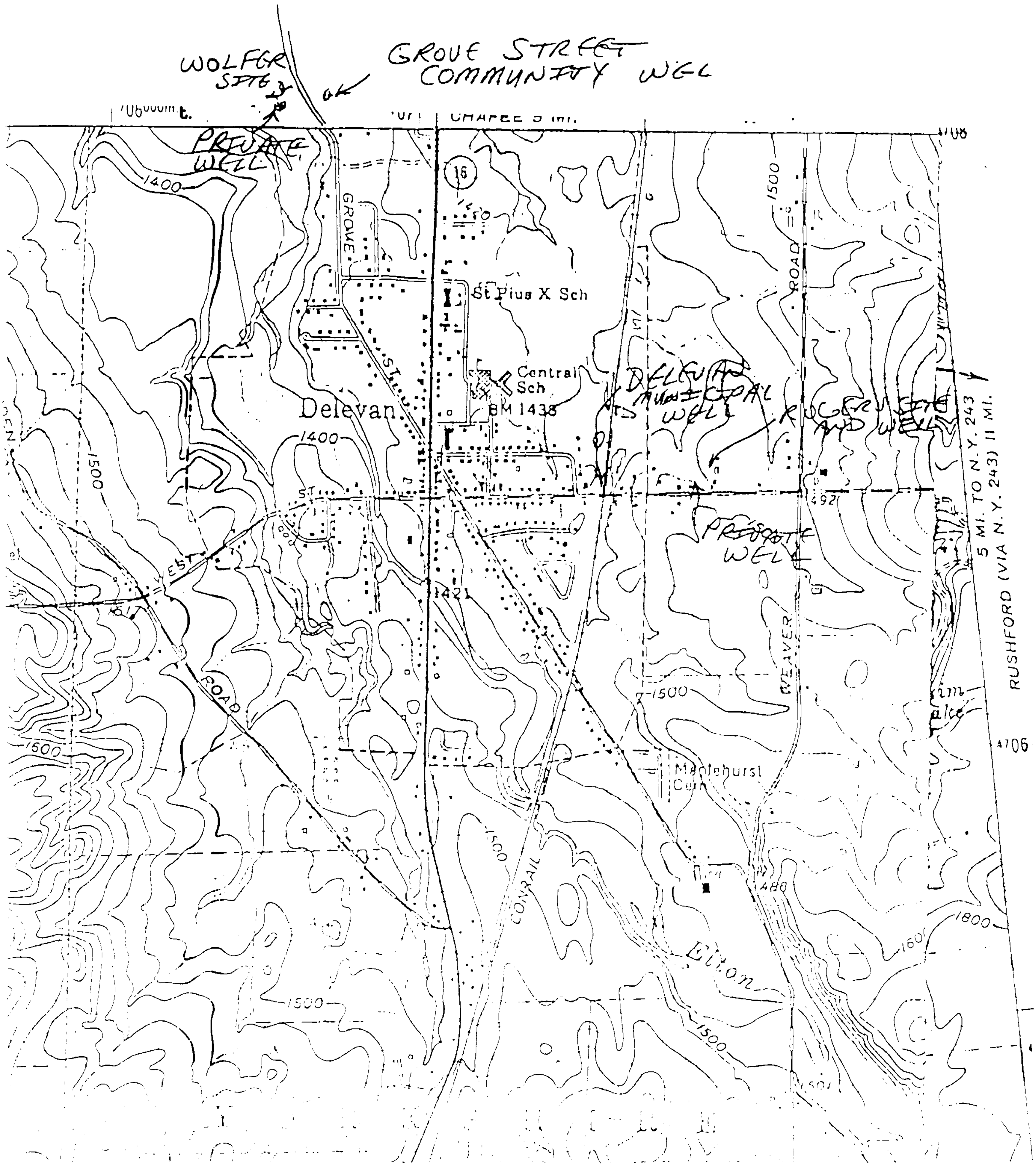
Arrowhead:

DEC officials should have knowledge of dump location on this site when they supervised closure of the dump in 1982. This site is not in the Allegheny River Basin.

RHJ/smw

WOLFER SITE

ROGER'S SITE



15 (12-75)

JD

New York State Department of Environmental Conservation

MEMORANDUM

Michael Wolfer
905020

TO: Gerald Pietraszek

FROM: Kevin Glaser KWG

SUBJECT: Motorola Sites

DATE: December 11, 1989

Last week Motorola, 12-8-89 as part of their continuing clean-up work, overpacked and moved 3 drums from the Michael Wolfer Site to the Terwillinger Site where they are stored inside his (Morton building) garage. Also stored in this garage are 6 drums overpacked at the Terwillinger Site. All other drums found at the Terwillinger site were empty; these were crushed and transported to the Norman Rogers Site and put in the roll-off box used for scrap metal disposal during that site's excavations. The drums stored inside at Terwillingers will be composited for disposal at a later date and the drum scrapped.

vam

cc: Martin Doster