PLEISTOCENE GEOLOGY OF THE EASTERN, LOWER HUDSON VALLEY, NEW YORK

Les Sirkin
Department of Earth Sciences
Adelphi University
Garden City, NY 11530

Donald H. Cadwell
New York State Geological Survey
Room 3140
Albany, NY 12230

G. Gordon Connally
12 University Avenue
Buffalo, NY 14214

INTRODUCTION

A preliminary understanding of the style of glacial retreat, in the eastern lower Hudson Valley, has been gained through mapping the surficial deposits between the Long Island-Staten Island end moraines and the Hudson Highlands. The present model of late Pleistocene glaciation for the region includes 1) a lobate ice front, 2) two distinct glaciations separated by a warm interval, and 3) final deglaciation with the sequential development of recessional moraines at some ice margins and extensive proglacial lake and valley fill deposits. This model is used in conjunction with field evidence to reconstruct the glacial history of the region. This field guide provides the basic framework for the glacial history and illustrates typical deposits and morphologic features. This article complements that of Connally, Sirkin, and Cadwell (this volume). For convenience, certain sections and descriptions are not repeated in both articles, but are cross-referenced.

PREVIOUS WORK

This model of late Pleistocene glaciation and deglaciation was developed during field examination of glacial deposits of the Lower Hudson Valley, Long Island, and Block Island, Rhode Island (Sirkin, 1982, 1986). A Late Wisconsinan Hudson Lobe probably existed during advance and retreat through this region (Sirkin, 1982). Two distinct drifts are represented in end moraines of western Long Island, (Sirkin and Mills, 1975; Sirkin, 1982, 1986).

The chronology of late Pleistocene glaciation and rate of deglaciation of the Hudson Lobe is derived from glacial ice-margin positions, radiocarbon ages and pollen stratigraphy (Connally and Sirkin, 1986). Connally and Sirkin, 1986, also trace the northward wasting of the glacier margin in the mid-Hudson Valley using moraines north of the Hudson Highlands in Dutchess and Columbia Counties. The deglacial chronology and pollen stratigraphy for the mid-Hudson Valley, west of the Hudson River, is summarized in Connally and others (1989; this volume).

BEDROCK GEOLOGY

Manhattan, Bronx, and Westchester Counties are underlain by rock formations of the Appalachian Fold Belt. Here the structure is similar to that of the Appalachian Blue Ridge with northeast-southwest trends and folds recumbently overturned to the northwest. Rock units include the Fordham Gneiss (generally associated with Grenville age tectonics and metamorphism), and the Lowerre Quartzite, Inwood Marble and Manhattan Schist of Cambro-Ordovician age. These units, the New York Group, were deformed and metamorphosed during the Taconic Orogeny. In southern Westchester County and adjacent Connecticut an additional sequence of early Paleozoic metamorphics, the Hartland Formation and the Harrison Gneiss, represent an accretionary facies. The Fordham and Hartland units exhibit structures of partial melting which give their outcrops a dramatically swirled appearance. The Fordham Gneiss is the most resistant rock unit in Westchester County and forms the highest ridges. The younger metamorphics of the New York Group are less resistant and support low ridges, or as the Inwood Marble, underlie the valleys. The Inwood is occasionally found folded against the resistant Fordham ridges and may directly underlie glacial deposits along the valley walls. The Lowerre Quartzite, originally a coarse clastic unit of fluvial origin, is discontinuously preserved along the trend of the Fordham. Vein quartz and pegmatite dikes of varying thickness cross-cut the Lowerre Quartzite and Fordham Gneiss.

In northern Westchester County (near Peekskill) the New York Group is intruded by an early Paleozoic basic rock unit known as the Cortlandt Complex.

GLACIAL DEPOSITS

Lower Till. In general the drumlin-shaped hills that form the uplands of southeastern New York are capped by a layer of glacial till up to 10 m thick. This appears to be a basal till deposited during the earlier of two glaciations. This lower till forms the north-south trending drumlins in Westchester County. It is usually medium to dark brown, blocky and oxidized on the blocky surfaces. Uplands formed on the resistant ridges of Fordham Gneiss and Cortlandt Complex have only thin patchy deposits of till. The lower till may be correlative with the "drumlin till" of southern New England.

Upper Till. The upper till appears poorly sorted, with occasional crude stratification and is interpreted to be a recessional deposit, such as ablation or meltout till. This unit is generally 1-3 m thick and may overlie the lower till. It may also occur as a meltout or flow till in ice-contact deposits. The upper till represents wasting of the Woodfordian glacier.

Many glacial erratics in the study area were quarried by the glacier from the rectangularly jointed bedrock units. Some erratics retain a rectangular shape and presumably were not transported far. Striations on bedrock surfaces generally trend north-northwest to south-southeast. Glacier flow from the north-northwest would account for Palisades basalt and Brunswick sandstone erratics of Hudson Lobe deposits in southern Westchester and western Long Island.

Stratified Drift. Outwash deposits are generally concentrated in main valleys, although occasionally found on the uplands too. Kame terraces occur in the Saw Mill, Grassy Sprain and Bronx River valleys, as well as in south-trending valleys in the Mamaroneck Quadrangle. A small kame is located against bedrock in the Kings Bridge area of the south Bronx.

An east-southeast trending valley with sand and gravel kame deposits extends from Tarrytown to Elmsford and White Plains. The White Plains part of this valley is the confluence of three north-south valleys intersecting the east-west valley and forming three distinct umlaufbergs.

Outwash and kame terraces fill many of the valleys in mid- and northern Westchester County, particularly in the Mianus River and Chappaqua Brook valleys. Kame deltas protrude laterally and southward into the Mount Kisco-Bedford Hills-Katonah valley.

The more prominent man-made lakes in Westchester County belong to the New York City reservoir system. The water bodies in the Amawalk and Titicus Creeks have drowned heads of outwash, kame and delta deposits, while active sand mining for new housing and industrial park sites have eliminated others. A kame delta located in apparent safety at Memorial Park in Bedford Hills vanished to the drag line in preparation for a condominium site, leaving only a smear of lake clays. Some heads of outwash are located east of Bedford, east of Jay High School, southeast of Somers, at Granite Springs, just north of Yorktown Heights, north of Katonah, and north of New Croton Reservoir.

The Croton Reservoir masks a possible stillstand of the ice margin. If real, this stillstand occurred when the retreating glacier formed the Croton Point Moraine (new name), and the Croton Point Delta (Figure 1, STOP 1). Similarly, the east-west valley trends at Yorktown Heights, Crompond, Jefferson Valley, Mohegan Lake, Lake Peekskill and Peekskill may denote ice margin positions. The valley of Peekskill Hollow Creek, has numerous ice contact kame deposits, one is a kame delta capped with coarse

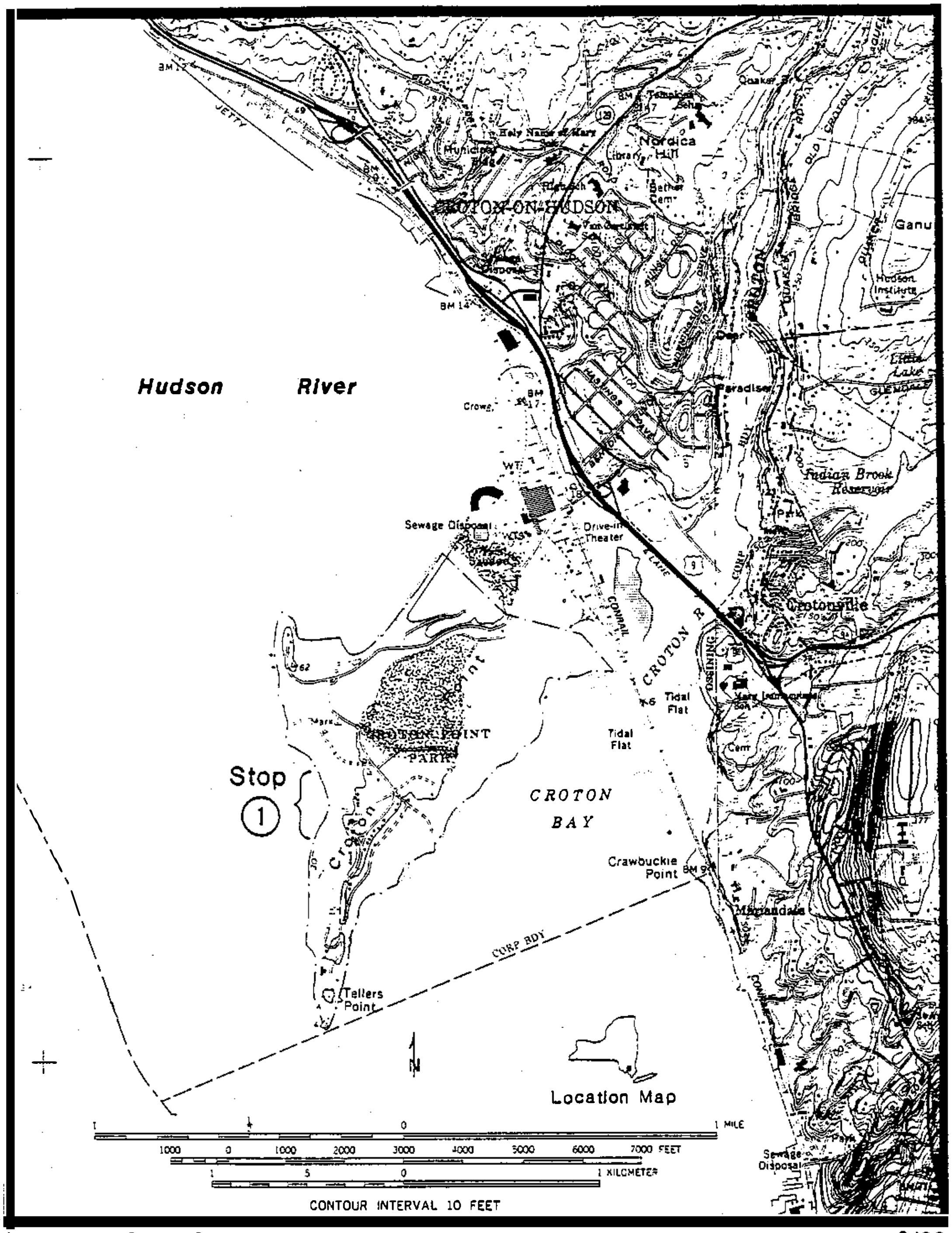

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Figure 1. Portion of the Haverstraw 7.5 minute U.S.G.S. topographic quadrangle illustrating STOP 1, Croton Point Park and vicinity.

gravel (Figure 2; and Fieldtrip Stop 3).

LACUSTRINE DEPOSITS

Lake-sand deposits are located adjacent to the Hudson River between Spuyten Duyvil and Irvington at an elevation of 100 ft. Artificial fill masks these deposits in Manhattan to the south and between Irvington and Ossining to the north. Lake sands are also preserved in Van Cortlandt Park, and the Saw Mill and Bronx River valleys. The Van Cortlandt Park deposits were formed during the development of Lake Hudson, while the Bronx River valley deposits may have formed during a northward extension of Lake Flushing. Glacial Lake Hudson developed between the Terminal Moraine and the retreating Woodfordian glacier margin and Lake Flushing formed in the position of the present Long Island Sound behind the end moraines on Long Island.

The best evidence of Lake Hudson in northern Westchester County is Croton Point, a large delta that juts into Haverstraw Bay (Figure 1.) This bay, just south of the Hudson Highlands, is a widened and overdeepened part of the Hudson estuary. Some of the glacial deposits can still be seen even though much of the delta has been eroded, mined for the brick-making industry, or covered by a landfill. Stratified drift is exposed locally on the hillslopes adjacent to the railroad. Grain size analyses of these deposits show fining toward the delta and the sediments may represent the topsets of the delta. The west end of Croton Point is composed of ablation till overlying stratified drift. Here, erosion of these deposits has left a lag of boulders, dominantly composed of Cortlandt, Palisades, Brunswick, and Highlands lithologies as a beach. Lake clays are also exposed in the cliffs along the west side of the Point a few feet above river level and overlying glacial drift. The clays appear to be rhythmites possibly deformed during initial glacial retreat from the Croton Point ice margin. Exposures of lake clay occur in the valley west of Harmon, near the mouth of Furnace Brook south of Crugers and in the valley just to the northeast of Crugers.

ICE MARGINS

The Sands Point Moraine of northwestern Long Island extends westward from the Sands Point Delta to the College Point Delta in northern Queens between Flushing Bay and the East River. This ice margin may continue westward along the east-west valley south of Steinway and then cross the East River to Manhattan. Lack of exposures of ice contact deposits in Manhattan's concrete massif, however, makes tracing this margin westward a mute effort. Only a small patch of outwash in northwestern Central Park and another at Mount Morris Park, both somewhat north of the projected Manhattan landfall, could mark the ice stand.

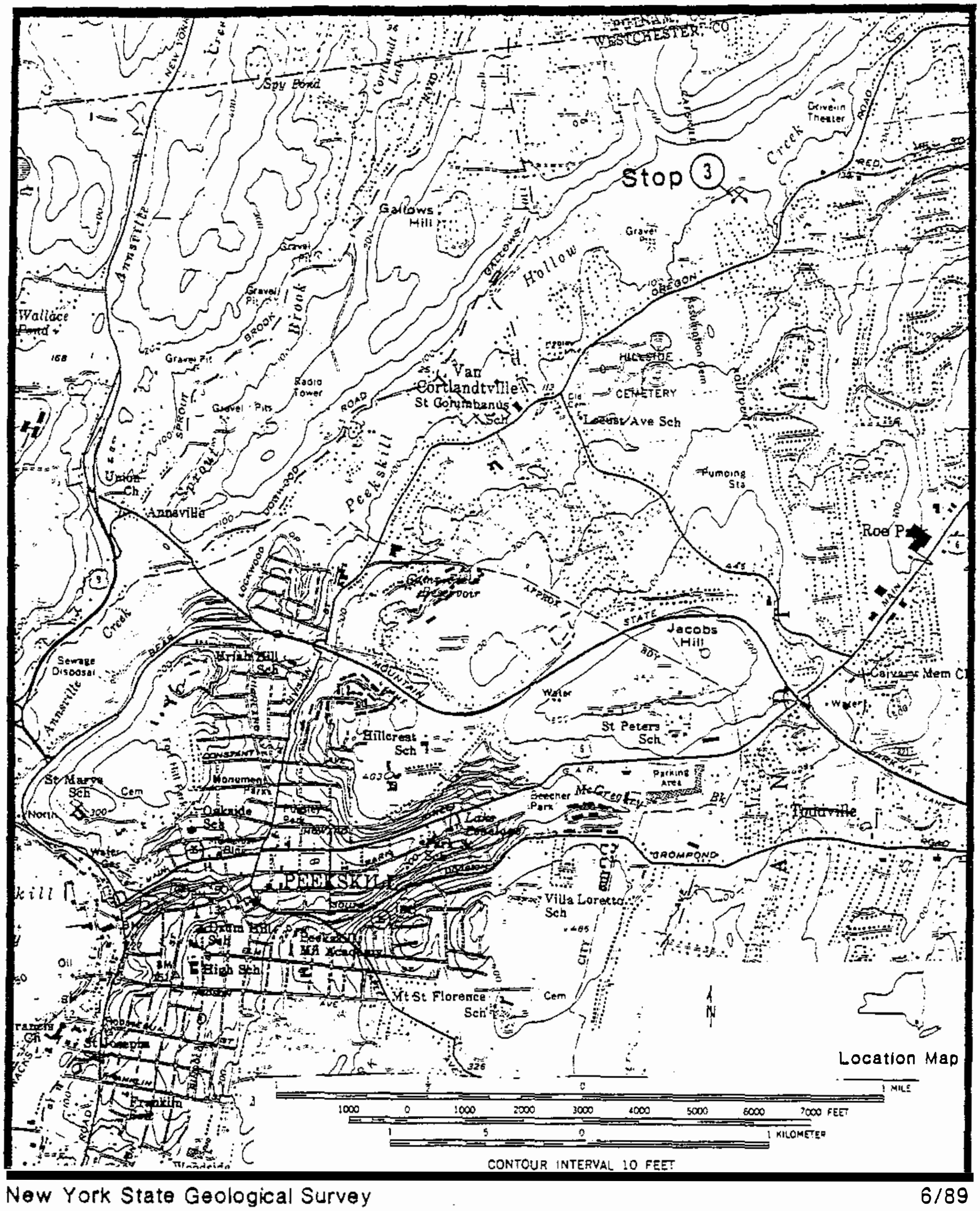

Figure 2. Portion of the Peekskill 7.5 minute U.S.G.S. topographic quadrangle illustrating STOP 3, Peekskill Hollow Creek and vicinity.

Similarly, the City Island Moraine, including Hart Island to the east, may extend westward to the south Bronx where thick till was exposed in a construction site on Castle Hill Avenue in Unionport. While this till could not be differentiated from lower till, the moraine might extend westward across the south Bronx and be correlated with two small till exposures in cemeteries near Trinity Church in northern Manhattan. It is apparent that the evidence for these ice margins west of the nominative moraines becomes highly speculative in the "high rise" terrane of New York City.

North of the City Island Moraine, there are no continuous features that permit the identification of moraines. Heads of outwash, kame terraces and kame deltas offer, however, tantalizing lures for speculation of ice margins in the Elmsford-White Plains Valley; the Bedford Hills-Mount Kisco Valley; and the Bedford-Mianus River Valley.

In the region of this field trip the most prominent ice margin is the Croton Point Moraine at Croton Point (Figure 1). This moraine denotes a position within the Hudson Valley and may possibly be extended eastward into the Croton Reservoir Valley. The Croton Point and Peekskill deltas substantiate the existence of Lake Hudson with a water plane elevation of 100 ft. The valley at Yorktown Heights forms another tempting location for an margin, but with only an outwash head as control. The ice contact kames in Peekskill Hollow possibly mark an ice margin in northern Westchester.

The Woodfordian glacier continued its retreat and deposited the Shenandoah Moraine on the north flank of the Hudson Highlands. Much of the glacial meltwater flowed directly into the expanding Glacial Lake Hudson, but during the early stages some meltwater flowed across the Highlands where sediments completely filled the upper Clove Creek valley (STOP 4).

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ROAD LOG FOR THE PLEISTOCENE GEOLOGY OF THE EASTERN, LOWER HUDSON VALLEY, NEW YORK

The Road log for this trip begins in Westchester County at the east side of the Bear Mountain Bridge. Figure 3 is a generalized County street map with the locations of Fieldtrip STOPS 1 and 3.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
0.0	0.0	East side of the Bear Mountain Bridge, Route 6 and 202; proceed south.
3.8	3.8	Junction Route 9 south, proceed on Route 9.
12.4	8.6	Exit Rt. 9 to Croton Point Avenue
12.5	0.1	Right on Croton Point Avenue
12.6	0.1	Traffic light, proceed straight onto one-lane bridge
13.8	1.2	Stay right after bridge to Croton Point Park; park at the west end of the large parking lot.

STOP 1. CROTON POINT PARK. Walk westward along the beach about 0.5 mi. to exposures of till and clay beds. Discussion will center on the evidence for the Croton Moraine and the Croton Point Delta (see Figure 1 in text). Note the lithologies of the boulders.

Return to cars.

15.3	1.5	Return to Rt. 9 north bound ramp. Proceed north on Rt.9

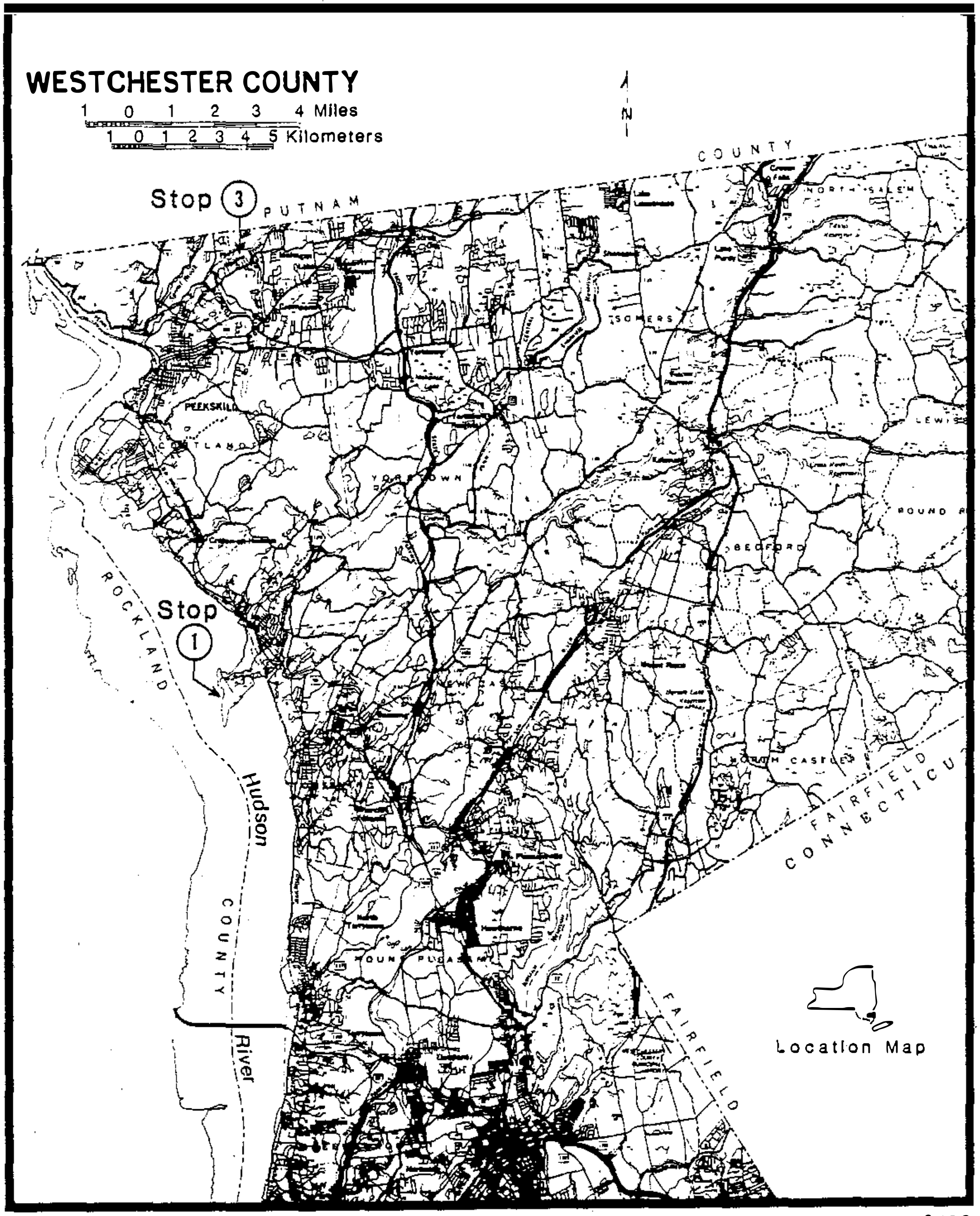

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Figure 3. Generalized street map of northern Westchester County with the location of Fieldtrip STOPS 1 and 3.

18.7	3.4	Exit Rt. 9 to 9A at Montrose exit
19.2	0.5	Follow 9A southbound to the south side of the bridge over the railroad.

STOP 2. PEEKSKILL HOLLOW CREEK: CLAY BEDS. Park at the entrance to the new railroad station construction site. Walk northeastward to stream bed. Examination and discussion of clay beds exposed in the stream banks.

Return to the cars.

19.7	0.5	Return to Rt. 9 north
24.8	5.1	Follow Rt 9 to the Bear Mountain Parkway, exit to eastbound lane.
26.4	1.6	Exit at Division Road; turn left on Oregon Road, the northeast continuation of Division Rd.
28.0	1.6	Entrance to Dam-Fino Construction Company on left.

STOP 3. PEEKSKILL HOLLOW CREEK: OUTWASH AND KAME DEPOSITS. Walk along the northbound lane in the yard, bear right at fork between trailer home and concrete building, follow lane to gravel pit. This pit has been excavated into one of the many outwash and kame deposits in Peekskill Hollow. Some kames show ice contact features. At this site a kame delta has been overtopped by flood gravels suggesting a change from deltaic to high energy fluvial deposition. Return to cars and proceed south on Division St.

Return to cars.

29.6	1.6	Junction Bear Mountain Parkway, turn right, proceed west.
29.8	0.2	Bear right toward Route 9
30.5	0.7	Junction Route 9, proceed north
32.0	1.5	Enter Putnam Co.
42.1	10.1	Enter Dutchess Co.
42.4	0.3	Enter sand and gravel operation on left

STOP 4. KAME DELTA. Proceed into gravel pit. This is a large kame delta complex constructed by meltwater flow through the Highlands during development of the Shenandoah Moraine.

End of field trip. Return to Route 9.