UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

GUIDEBOOK

44th Annual Meeting of the Friends of the Pleistocene, Nashua River Valley, Leominster, Massachusetts

May 15-17, 1981

by

Carl Koteff and Byron D. Stone

Open-File Report 81-651

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

1981

SCHEDULE

Friday, May 15, 1981

Late afternoon and evening.
Friendship and renewal of old acquaintances, Holiday Inn, Leominster, Mass. No formal schedule.

Saturday, May 16, 1981

Breakfast will be available at 6:00 a.m. in the Holiday Inn dining room. Busses will be at the lower parking lot at 7:30 a.m. We will leave immediately as there is much to see over a long distance. Some pain suppressors will be supplied during the day, however. Lunch will be at Stop 5. Please make sure to leave no trash. Gravel-pit operators these days are very careful not to offend OSHA (Occupational Safety and Health Administration), and they try very hard to be clean neighbors. Plastic bags will be available for lunch trash. We are aiming to be back at the Holiday Inn by 5:15 p.m. for showers.

6:45 p.m. Busses will depart from parking lot for the Old Mill Restaurant in Westminster.

7:00-8:00 p.m. Socializing. Beer is free, cash bar available for harder stuff.

8:00 p.m. Annual Dinner, buffet style. A short discussion will follow on what we should have seen today and what we will see on Sunday.

10:30-11:00 p.m. (Flexible) Busses return to the Holiday Inn.

Sunday, May 17, 1981

Breakfast available at Holiday Inn beginning at 6:00 a.m. Busses will leave the parking lot at 8:00 a.m. We hope to get back in time for people to clean up before they check out of the Holiday Inn by lunch time.

INTRODUCTION

The Nashua River valley drains north-northeast, from a major watershed near Worcester, Massachusetts, to Nashua, New Hampshire, a distance of about 50 km. South of this watershed, drainage eventually reaches Block Island and Long Island Sounds. A watershed to the east separates the Nashua Valley from drainage that flows toward the Concord River system. Three major tributaries, the Stillwater, North Nashua, and Squannacook Rivers join the Nashua River from the northwest. This setting was ideal for the formation of a large glacial lake, named Lake Nashua (fig. 1) by W. O. Crosby (1899), that formed during retreat of the last Wisconsinan ice sheet to overrun New England. As soon as the northward-receding ice margin backed away from the divide near Worcester, an instant glacial lake was created, and large volumes of sand, gravel, silt, and clay were deposited in deltas, lake bottoms, and other associated lacustrine features. Large bodies of outwash were laid down graded to the lake in all the major and minor tributary valleys as well as the main valley itself, and nearly all the ice-contact and proglacial forms associated with melt-water deposition were constructed. As the ice margin systematically retreated northward, successively lower outlets along the eastern valley wall were uncovered, resulting in successively lower lake stages.

W. O. Crosby, working as a consultant to the (Boston) Metropolitan Water Board during the construction of the Wachusett Dam at Clinton during the late 1890's, was the first to recognize the deltaic features (Crosby, 1903-1904) deposited in the lake basin. Crosby described the major earlier stages of the lake and related these to the history of glacier retreat. W. C. Alden worked in the area in the early 1900's and refined in more detail Crosby's descriptions, although Alden's results were not published until 1924. R. H. Jahns mapped the Ayer, Massachusetts, 7 1/2' quadrangle in 1941 (published in 1953) and described a few more stages of Lake Nashua in the northern part of the basin. This was part of the area where Jahns first developed his ideas on the sequence concept of melt-water deposition, but he mainly restricted application of the sequence concept to fluvial deposits, and he divided Lake Nashua by stage only. Since the 1960's and 1970's, Koteff (1966), Koteff and Volckmann (1973), and Stone (1980) have adapted the concept now called the "morphosequence concept" to explain the lake deposits as well.

Perhaps the most graphic demonstration of the morphosequence concept is provided by deposits and base-level controls of former glacial lakes formed in north-draining valleys such as the Nashua. The combination of factors such as a receding "requisite ice barrier" (Alden's term, 1924) to the north, stable spillways that controlled lake levels, delta deposits that indicate specific lake levels, and textural gradation of coarse to fine from head of outwash downstream help to demonstrate the systematic nature of ice retreat. The lack of "live ice" evidence such as ice-shove structures at the heads of deposits strongly suggests that the systematic ice recession was by stagnation-zone retreat.

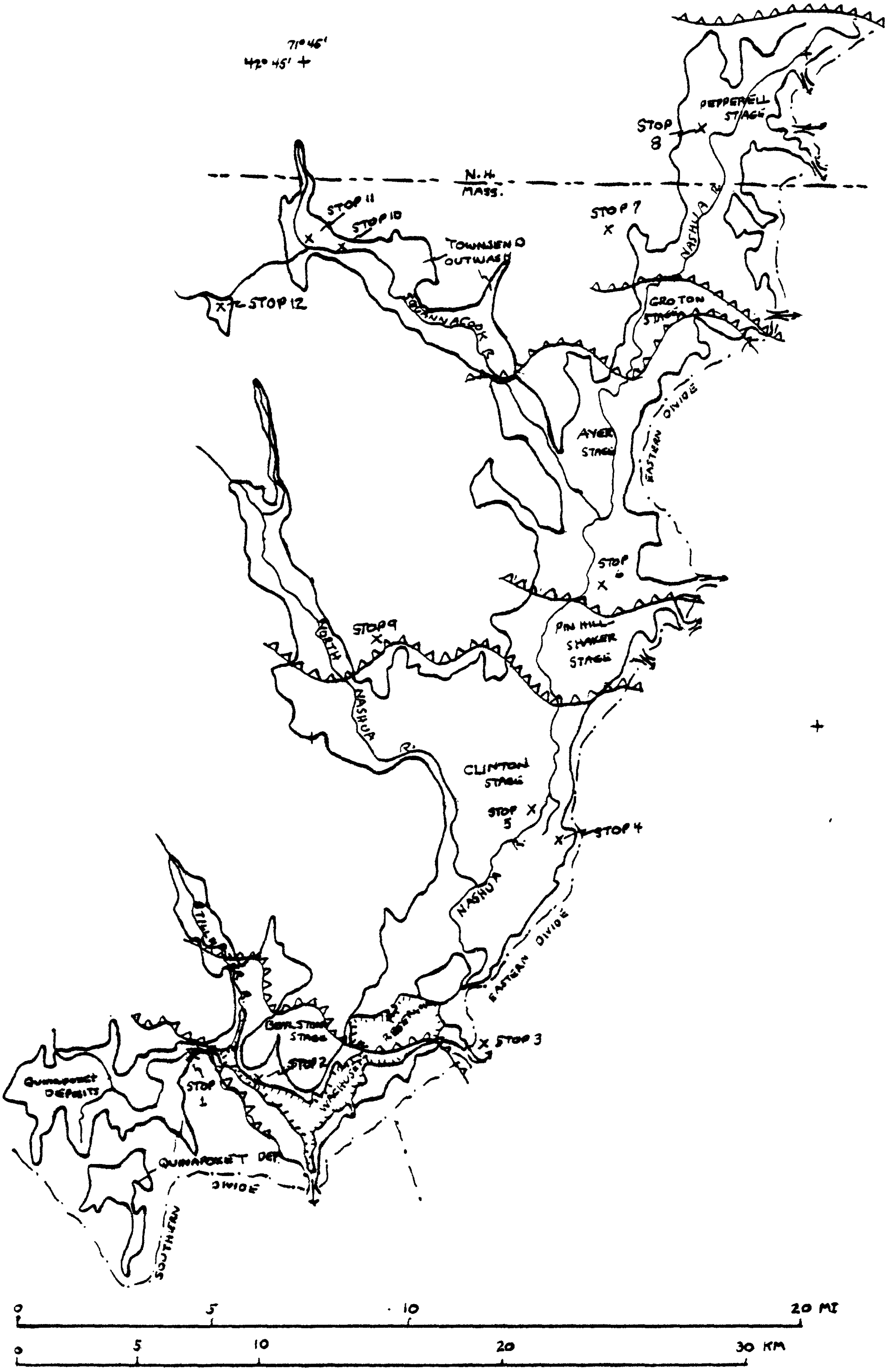


Figure 1.--Sketch map of the maximum extent of glacial Lake Nashua (heavy line), showing its stages, outlets (arrows), and related ice-margin positions (sawteeth).

STOP 1: HOLDEN TOWN SANITARY LANDFILL - DELTAIC DEPOSITS

The active face in the east side of the pit at Stop 1 exposes deltaic sediments of Malden Brook deposits (Stone, 1980), which were deposited in and graded to an ice-marginal pond which emptied through a melt-water carved spillway at altitude 575+ ft south of Malden Street in the Worcester North quadrangle. The upper depositional surface is just over the 600-ft altitude at the pit (fig. 2) and rises to over 610 ft toward the northwest. Cobble gravel of older Quinapoxet deposits forms collapsed ice-contact knolls at altitudes of 650+ ft immediately west of the landfill.

The deltaic section at the landfill is typical of exposures in higher and older glaciolacustrine deposits in the Quinapoxet River valley to the south. Alden (1924, plate 1) showed some of these deposits as units of the earliest Quinapoxet stage of glacial Lake Nashua. Glacial lake deposits of the Quinapoxet Valley consist of sediments laid down in small upland basins; deltaic deposits commonly fill the basins, and no large body of open water was present during ice retreat. The Quinapoxet deposits are differentiated in the sketch map (fig. 1) from Lake Nashua deposits, which lie in the Nashua River lowland proper. The oldest deposits of Lake Nashua are the Boylston-stage deposits.

The landfill pit exposes a thick section of fluvial topset beds, deposited subaerially in braided outwash streams, and foreset beds, deposited subaqueously.

Thickness	Unit Description
0 - 0.5 m	Eolian fine to medium sand, buff-colored, containing coarse sand and gravel derived from underlying sediments.
4 - 5 m	Fluvial sand and pebble gravel; horizontal, alternating sets of flat beds 0.1 to 0.3 m thick, and sets of tabular and tangential trough crossbeds 0.1 to 0.2 m thick; beds appear laterally continuous along the pit face, crossbeds dip easterly; a bed of pebble gravel, 1 m thick, caps the fluvial section.
3 - 5 m	Sand, silt, pebble gravel, and pebbly sand in dipping delta foreset beds; foresets consist of alternating sets of thin flat beds, and sets of ripple-drift cross-laminations; foresets dip 25^{o} toward the east.

Although collapse structures are relatively uncommon in the pit face in this distal part of the deposit, paired high-angle reverse faults, which are convex upward, indicating collapse over small buried ice blocks, were exposed near the pit entrance. Also, extension fractures, along which little vertical offset is apparent and which extend as deep as 8 m, were exposed in the east wall of the pit. These are attributed to large-scale extension caused by melt out of thin blocks of buried ice or compaction and movement of underlying fine sediments.

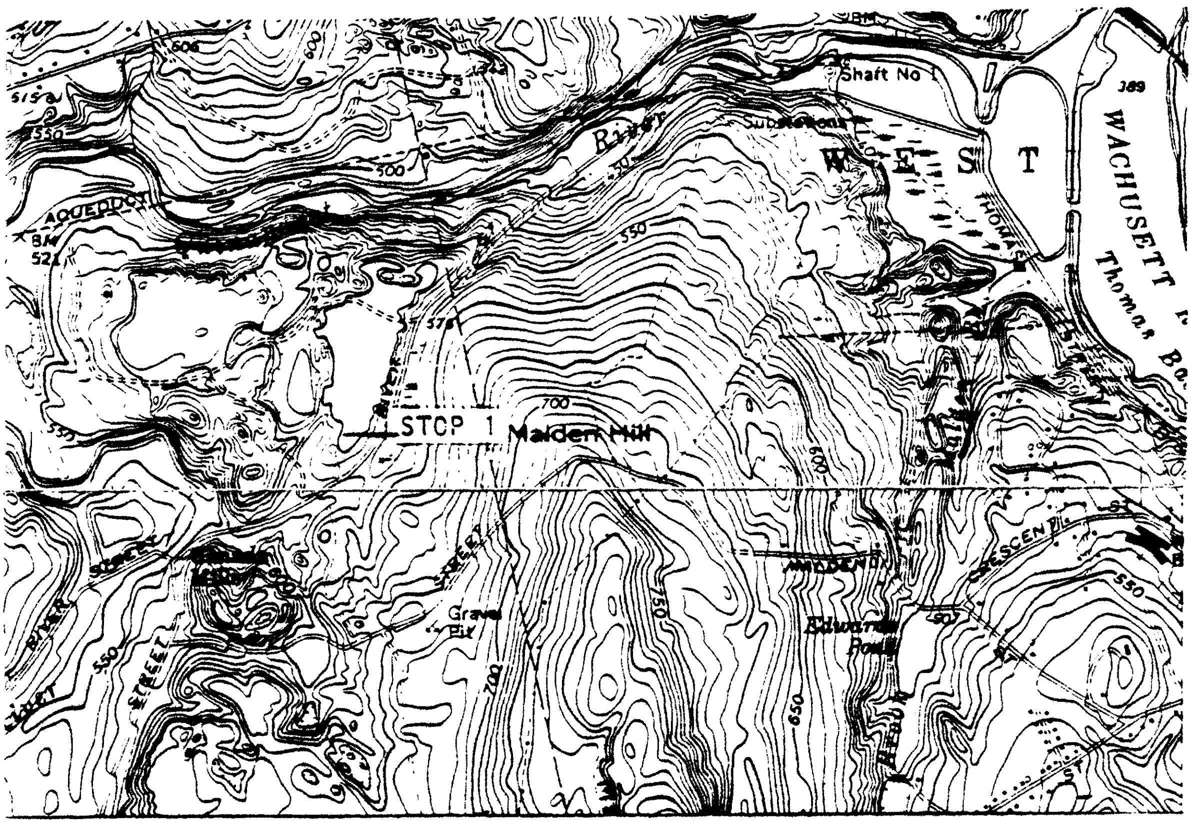
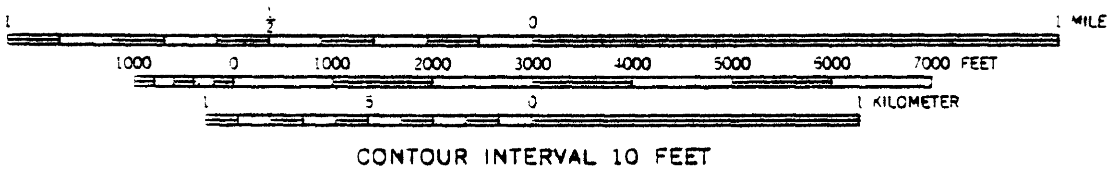


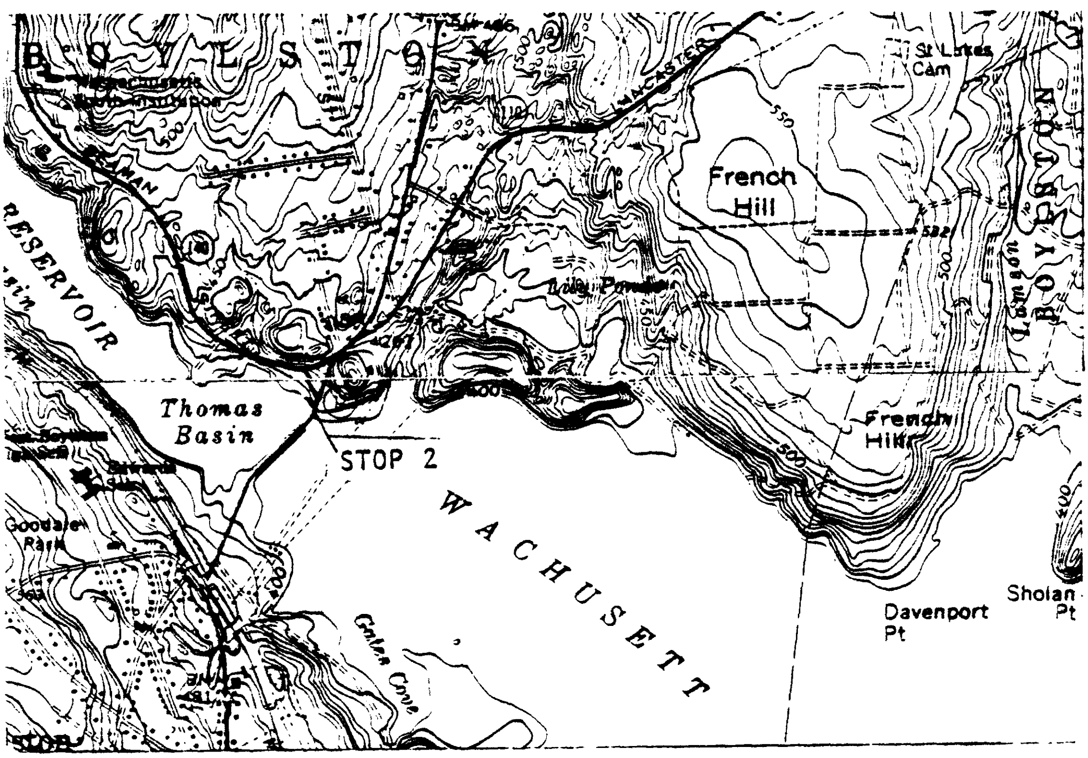
Figure 2.—STOP 1, Topography from U.S.Geological Survey maps of Sterling and Worcester North 7 1/2′ quadrangles.



STOP 2: WACHUSETT RESERVOIR - SOUTHWEST STRIATIONS

Striations on outcrops at the northwest side of the bridge at Stop 2 (fig.3) trend S36°W to S41°W, about 45° west of the regional south-southeasterly trend of upland striae and drumlins. The striations here record the last movement of active ice in the Nashua lowland, which probably took place while the stagnant edge of the ice sheet lay along the uplands to the southwest. Southwest-trending striae and drumlins are common along the west side of the Nashua River basin, which extends along the east side of the central Massachusetts Upland. South- and southwest-trending ice-flow indicators are found as far east as the central part of the adjacent Clinton and Shirley quadrangles, indicating a fanning pattern of ice flow in the Nashua lowland during the final stages of ice retreat.

Ice-contact deltas of Lake Nashua form irregular, locally flat-topped hills at altitudes of 470 to 480+ ft in the vicinity of Stop 2. These deltas were graded to the Boylston stage of the lake which was controlled by a bedrock-floored spillway, altitude 450 ft, at the south end of Wachusett Reservoir. Fluvial pebble gravel, which underlies terraces at altitudes of 390 to 400+ ft in the vicinity of Stop 2, unconformably overlies Boylston-stage lacustrine deposits. The younger fluvial gravel was deposited by melt water that flowed on grade to the Clinton-stage lake level, which was controlled by the spillway at Rattlesnake Hill (Stop 3).



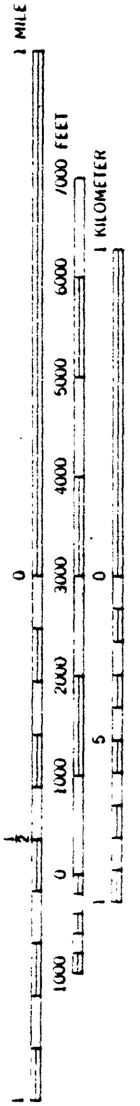


Figure 3.—STOP 2, Topography from U.S. Geological Survey map of Sterling and Worcester North 7 1/2′ quadrangles, Massachusetts.

STOP 3: RATTLESNAKE HILL SPILLWAY

The Rattlesnake Hill spillway at Stop 3 (fig. 4) was the bedrock-floored outlet for the Clinton stage of glacial Lake Nashua. The width of the channel here is about 75 m, and the prominent rock rampart, which was the stable base-level control for the lake, just catches the 350-ft contour. The bedrock, a binary granite of Devonian age, has been called the Rattlesnake Hill Muscovite Granite of Skehan (1968). The swamp is probably underlain by sand to pebbly sand similar to that mapped a few hundred meters to the north. W. C. Alden (1924) thought that the spillway had been eroded down from the 400-ft level, but although there are signs of erosion of the till bank just north of the farmhouse, we think that the Clinton stage was controlled by the bedrock rampart immediately after ice uncovered this channel. Alden recognized that the Clinton terrace, visible from Stop 2 and at an altitude of 400 ft, had fluvial structures, but thought it signified a Clinton stage at that altitude. However, the fluvial deposits at Stop 2 are on grade for about 8 km before reaching the 350-ft altitude here and probably do not represent a higher Clinton stage. Question, how high could the water have been at this knickpoint?

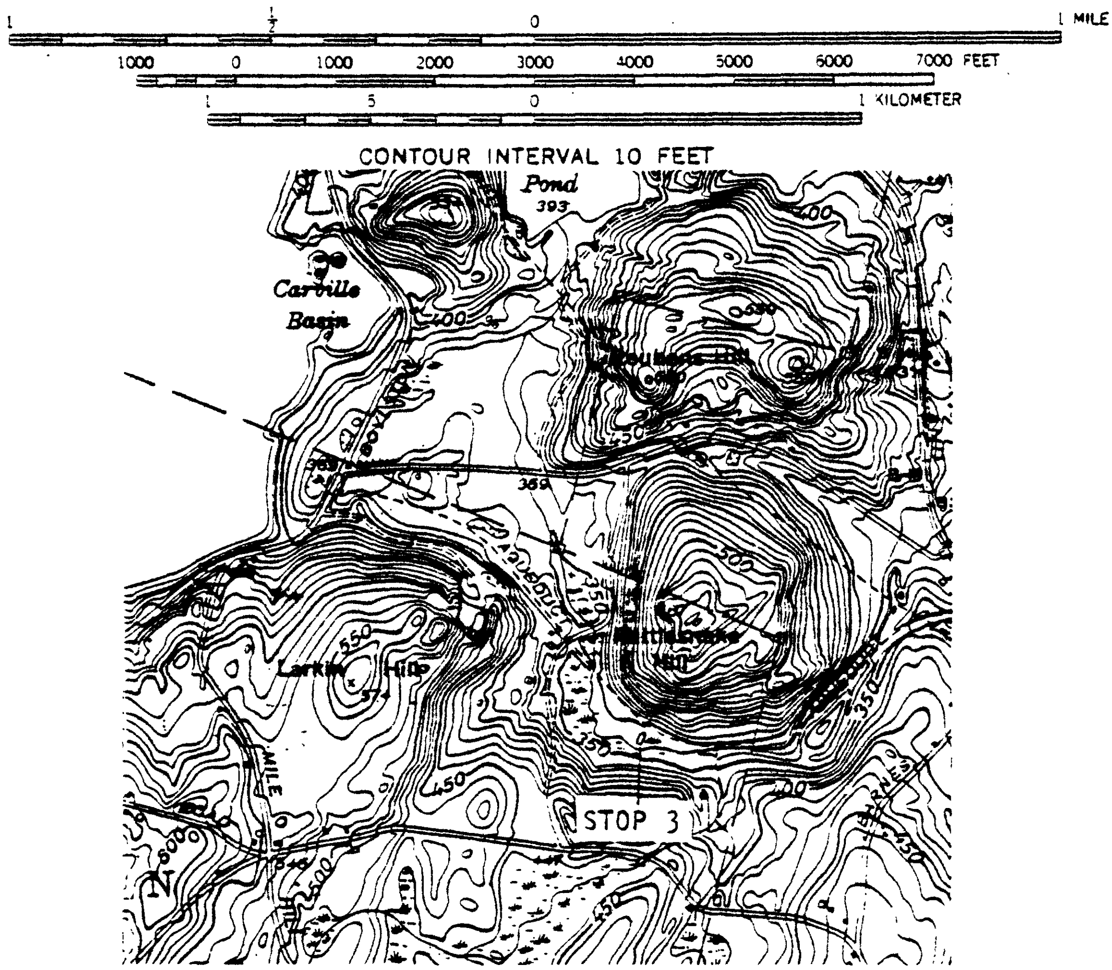


Figure 4.—STOP 3, Topography from U.S. Geological Survey map of the Clinton 7 1/2′ quadrangle, Massachusetts.

STOP 4: BOLTON ORCHARD DELTA

Lower pit

The exposure at Stop 4 (fig. 5) is in a delta constructed in Lake Nashua, controlled by the Rattlesnake Hill spillway, during about the middle of Clinton-stage time (assuming a steady rate of ice retreat). The top of the exposure is at about 300 ft altitude and the bottom at about 265 ft altitude. The altitude of the lake itself was about 380 ft here. Morphologically, the feature is a kame terrace, deposited between the valley wall to the east and lobate ice convex to the south. Dips of the foresets are predominantly to the southwest; foresets are interbedded pebble to cobble gravel and sand in low-angle sets, although collapse tends to mask the actual dip in places. The lowest part of the exposure shows about 3 m of sand and fine sand containing abundant sand-size fragments of phyllite, and cut by high- to low-angle normal faults. Above the lower sand is 5 to 6 m of pebble to cobble gravel having low dips and showing less collapse. Individual beds in this horizon are 5-30 cm thick. In the upper part of the exposure, planar foresets show increasing ripple-drift lamination upsection. Kettle fillings can be seen in places.

Upper exposure

Topset beds of pebbly sand are 1 m or less in thickness and show some cut and fill structures. Upper parts of foresets show increasing rippling. Source of uppermost beds is at least 3 km to the northeast.

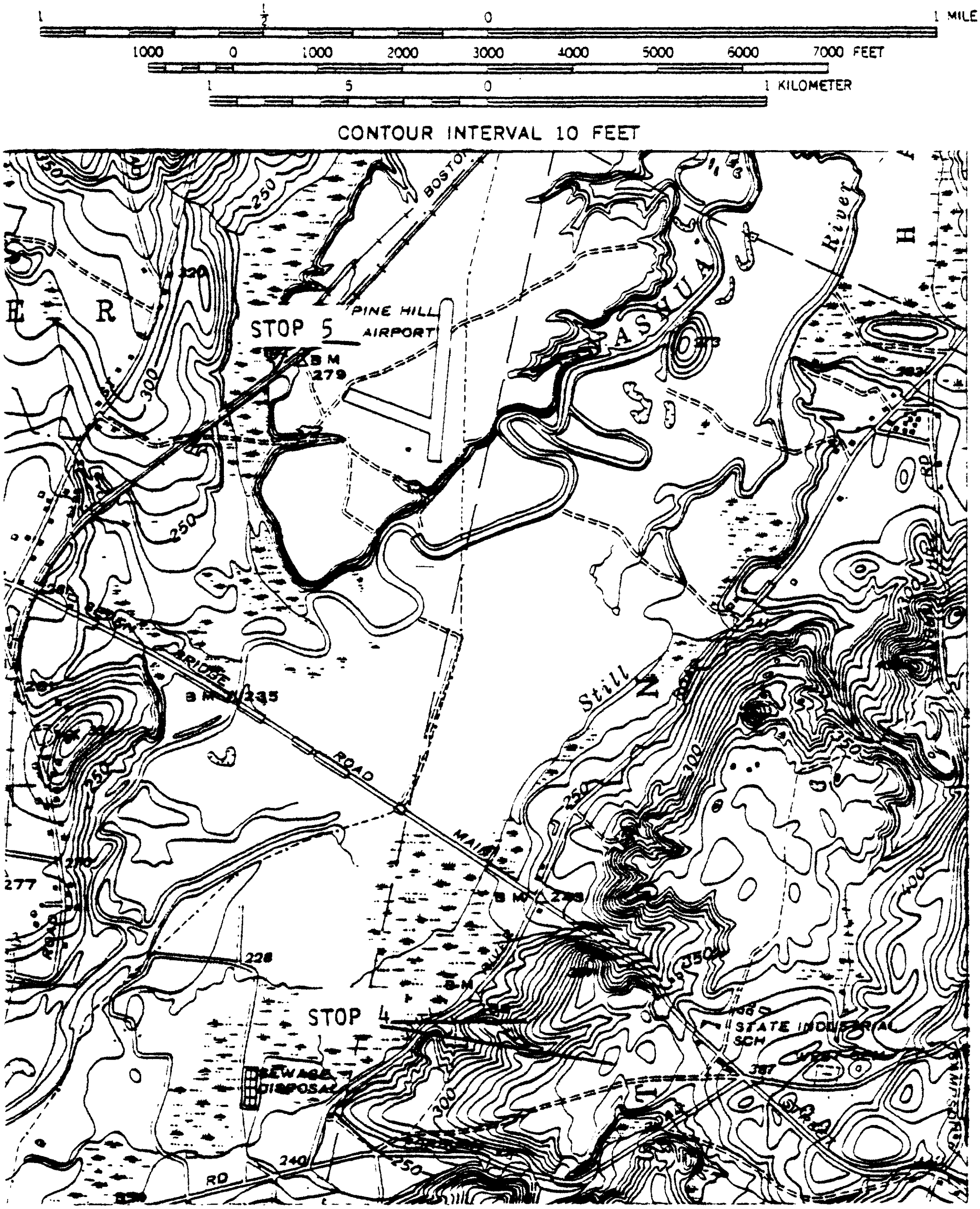


Figure 5.—STOPS 4 and 5, Topography from U.S. Geological Survey map of the Clinton 7 1/2′ quadrangle, Massachusetts.

STOP 5: PINE HILL PIT - FLUVIAL AYER-STAGE DEPOSITS

The deposits in the Pine Hill pit at Stop 5 (fig. 5) were shown by Koteff (1966) to belong to the Ayer stage of glacial lake Nashua. The present exposure is more than 7 m of moderately well sorted, interbedded, fluvially laid sand and pebble gravel (more than 10 m have been observed in the past). Sets of tabular and tangential crossbeds are as thick as 0.5 m; troughs are generally 0.5 m wide but some are as much as 2 m wide. Virtually all beds are crossbedded and consistently dip northward; the surface also slopes gently northward. The sand has less silt and rock fragments than sand in the Bolton Orchard exposure; pebbles are well rounded. The fluvial beds overlie and are channeled into rippled cross-laminated fine sand and micaceous silt that are thought to be lake-bottom deposits of an earlier (Clinton) stage of Lake Nashua. The fluvial beds are presumed to be graded to the level of the Ayer-stage spillway, about 8 km north of here, that R. H. Jahns (1950) stated had an altitude of about 250 ft. The bases of the fluvial beds here are lower today, but this problem can be explained by allowing for postglacial tilt of about 80 cm/km. The pebbly sand and gravel here were laid down chiefly by meteoric water originating in the upper part of the Nashua Valley to the south, which eroded a great deal of Clinton-stage deposits. Some component of Pine Hill deposits probably had a glaciofluvial origin as melt-water deposits from the ice margin continued to be laid down in the North Nashua valley to the west and northwest, and some sand and gravel may have reached Pine Hill from this source.

STOP 6: FORT DEVENS SANITARY LANDFILL - DELTAIC DEPOSITS

The exposure at Stop 6 (fig. 6) is in a delta composed chiefly of sand in foresets that dip westerly and even northwesterly. Topsets are not well shown. Jahns (1953) mapped this feature as a glaciofluvial deposit in a numbered (morpho) sequence graded through the Ayer gap to the east, so probably did not see any exposures at this locality. The problem here is the apparently anomalous up-ice dips of the foreset beds. We suggest that the sand at this exposure is a downstream lacustrine facies of a fluvial deposit much like that at Pine Hill, deposited into the Ayer-stage lake that still contained many detached stagnant ice blocks. The source area for this deposit is probably to the west, where abundant slightly older melt-water deposits were eroded and material was transported eastward into the lake. Ayer-stage delta deposits laid down in contact with the ice margin itself occur to the north.

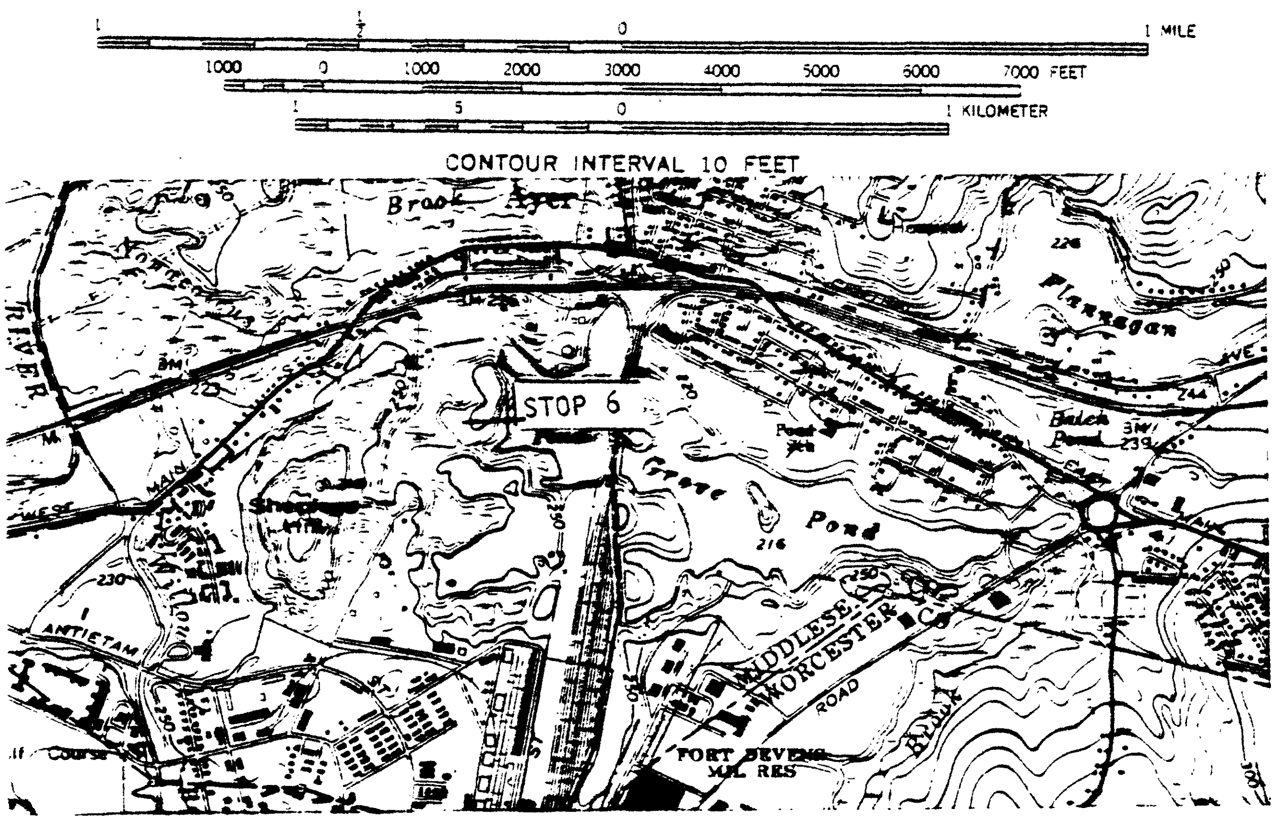


Figure 6.—STOP 6, Topography from U.S. Geological Survey map of the Ayer 7 1/2′ quadrangle, Massachusetts.

STOP 7: TWIN VALLEY FARM MELT-WATER CHANNELS

The two nearly parallel channels on either side of Brookline road at Stop 7 (fig. 7) are cut in till that was derived from very soft and erodable phyllite. The upper part of the southern channel heads at about 295 ft altitude and the lower end is at about 235 ft altitude. It has a length of more than 300 m, and the slope is thus more than 13.5 m/km. Bedrock is exposured at the middle and upper ends of the channel and very possibly floors the entire length. The phyllite is so soft that it is sometimes difficult to distinguish it from the till throughout this area. Large boulders occur on the channel floor.

The northern channel heads at just over 270 ft altitude, and the lower end is around 235 ft altitude. The channel is about 915 m long and has a gradient of about 11.5 m/km. No bedrock is exposed anywhere in this channel, but again, the soft phyllite is sometimes difficult to find. No boulders are found throughout the channel's length.

The southern channel has cobble and boulder gravel deposits in its lower end and is thus interpreted to be a feeder course for an early phase of the Pepperell stage of glacial Lake Nashua. After the stagnant ice front retreated a short distance north, it maintained its position there while the northern channel was cut. The northern channel, which has no melt-water deposits or boulders on the floor, is interpreted to be the outlet for a small glacial lake to the west that now contains the Sucker Brook #2 deposits. This discussion is an example of how many small pieces and bits of evidence are put together on a regional scale to demonstrate systematic stagnation-zone retreat.

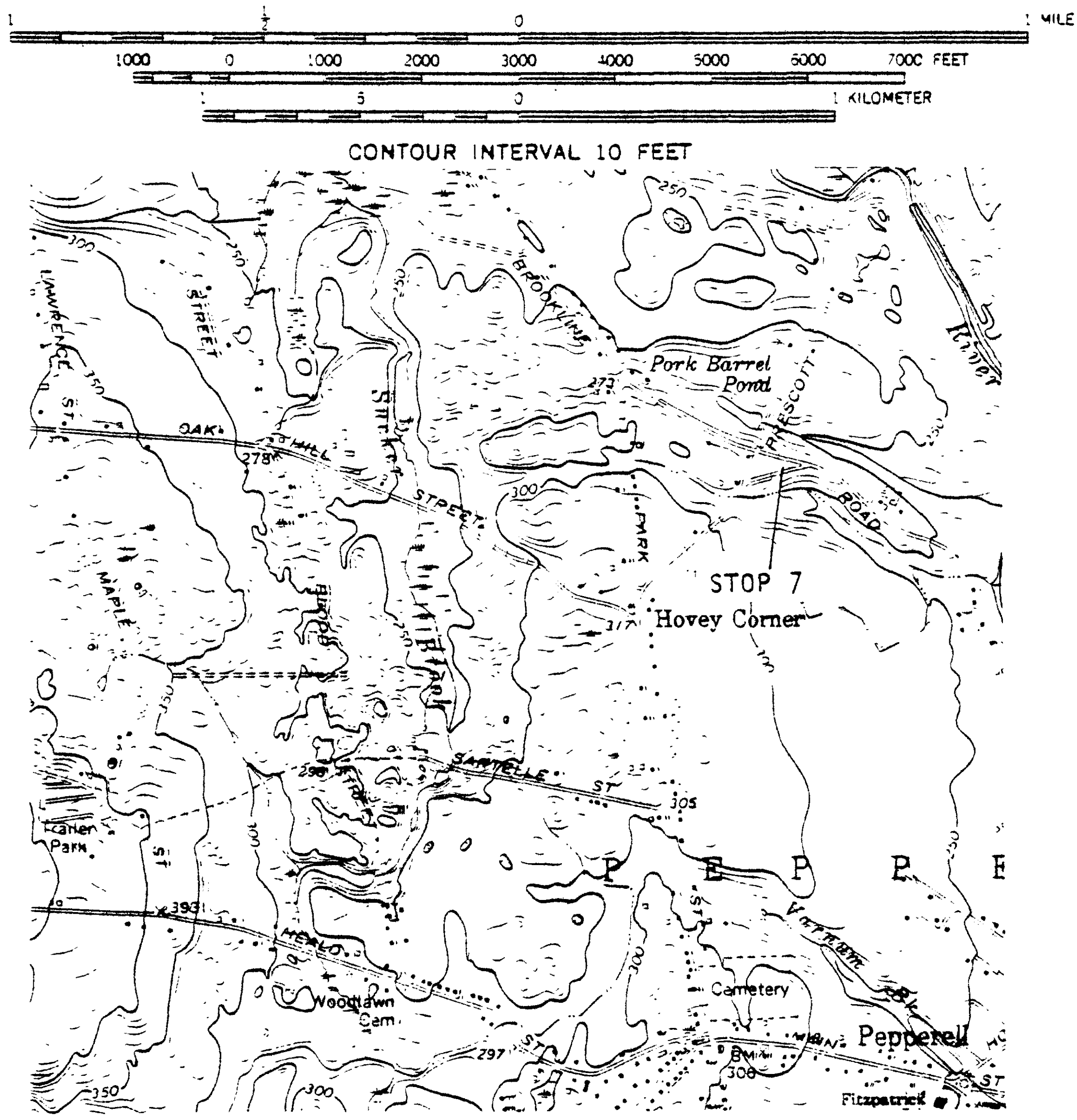


Figure 7.—STOP 7, Topography from U.S. Geological Survey map of the Pepperell 7 1/2′ quadrangle, Massachusetts and New Hampshire.

STOP 8: HOLLIS SANITARY LANDFILL - TERRACED LAKE BEDS

The exposure at Stop 8 (fig. 8) is very limited and because of the haphazard dumping of trash, it can be potentially hazardous. Please be careful.

Pebbly sand and gravel fluvial beds about 1 m thick overlie lacustrine beds of a later phase of the Pepperell stage of glacial Lake Nashua. The lacustrine deposits probably are associated with the higher kame delta immediately to the west and have been truncated and are now overlain by pebbly sand and gravel. The fluvial beds form a terrace that appears to be graded to the highest post-Merrimack Lake stream terrace at Nashua, New Hampshire, more than 10 km to the northeast. This terrace is kettled and thus indicates that some buried ice in this vicinity did not melt away until the main ice front had retreated at least as far as Manchester, New Hampshire, more than 32 km north of here.

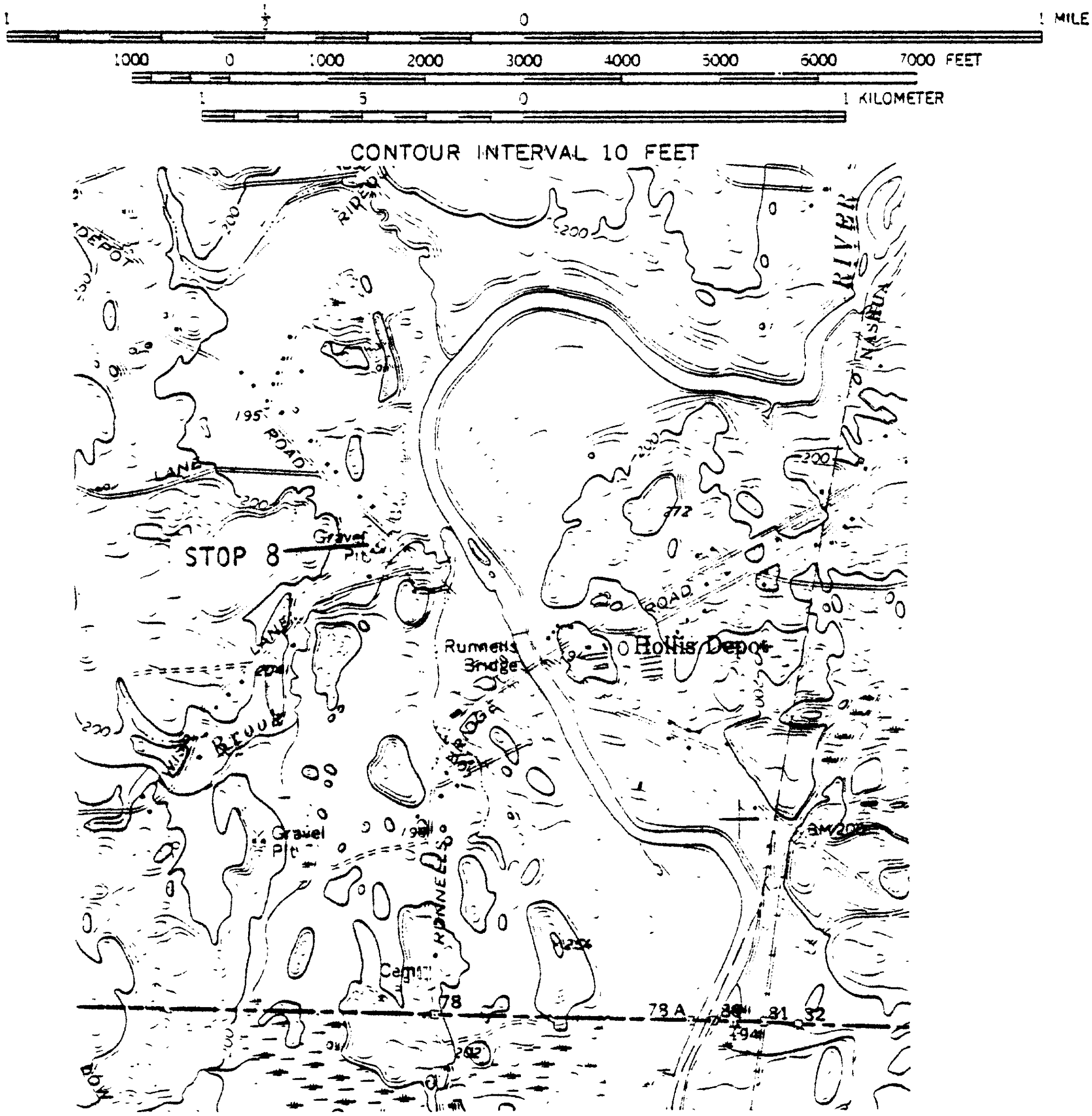


Figure 8.--STOP 8, Topography from the U.S. Geological Survey map of the Pepperell 7 1/2′ quadrangle, Massachusetts and New Hampshire.

STOP 9: JOCELYN HILL SANDPIT

The sandpit at the south end of Jocelyn Hill (fig. 9) exposes deltaic sediments, which overlie a complex till section in the downstream end of the drumlin. The exposed section is measured from the top downward:

Thickness	Unit Description
1 m	Fluvial pebble-cobble gravel, delta topset beds, in horizontal beds 0.1-.2 m thick separated by thin sand interbeds.
8 m	Sand, pebbly sand, pebble gravel, and silt in dipping delta foreset beds; foresets consist of flat beds alternating with local sets of ripple-drift cross-laminations in silt to medium sand beds; foresets dip 25° to the southeast, south, and southwest.
2 m	Gray, sandy till, distinctly bedded and containing angular cobbles and lenses of stratified, angular pebble gravel; bedding consists of sets of irregular, laterally discontinuous laminations of sand and silt, alternating with beds of massive till 1-10 cm thick; massive till is fairly compact.
2 m	Olive-gray, compact till, having silty matrix and containing few gravel-size clasts; this till appears to be the "old" or drumlin till of southern New England, although it lacks the characteristic platy structure.
0.5 m	Interlayered sand, compact till, and sets of sand/silt laminations; layers are generally less than 5 cm thick.
2 m	Buff to yellowish sand having a pale pink cast; alternating beds of medium to coarse sand and granular to pebble gravel; local set of tabular crossbeds 0.2 m thick; sand is faulted and contains silt and fine sand injections along fault traces; subhorizontal shear zones are common at top.

How much of the till is in place? Is the upper stratified till related to the ice-dammed pond into which the delta prograded, or is stratified till typically found in the lee ends of other drumlins? Can some of the interlayering at the top of the lower sand be attributed to glacial shear?

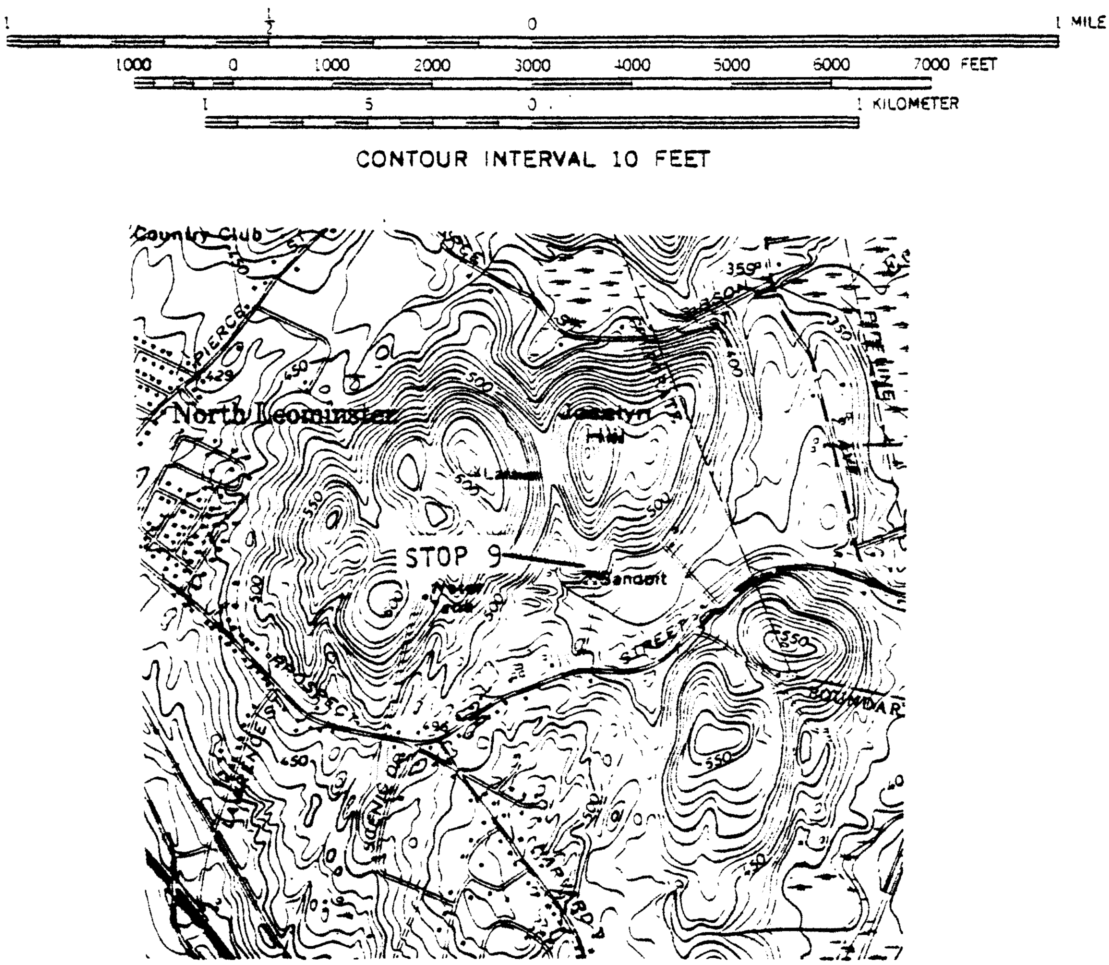


Figure 9.--STOP 9, Topography from U.S. Geological Survey map of the Shirley 7 1/2′ quadrangle, Massachusetts.

STOP 10: SANDPIT, TOWNSEND OUTWASH

The pit at Stop 10 (fig. 10) exposes 5 m of micaceous sand and silt containing few pebbles, deposited in a distal fluvial environment about 6 km from the sediment source in the Mason Brook valley. Horizontal beds consist of sets of flat beds, commonly less than 20 cm thick interbedded with tangential trough crossbeds in sets $\leq$ 30 cm thick and in cosets as thick as 1.2 m. Direction of dip of crossbeds is variable but is generally southeasterly. A few sets of ripple-drift cross-laminations, less than 35 cm thick, are also present. Exposed across the face of the pit are channels having broad concave erosional bases filled by sets of beds with aggregate thickness of about 1 m. What bedforms and channel patterns would produce these structures and channel geometry? Ball and pillow structures and other minor deformation features are common in fine sand and silt beds.

STOP 11: SAND AND GRAVEL PIT, TOWNSEND OUTWASH

Sand, granular to pebbly sand, and pebble to cobble gravel is exposed in the pit at Stop 11 (fig. 10) and in pits to the north. Bedding consists of sets of tangential trough crossbeds in sets $\leq$ 30 cm thick. The upper meter of sediment is a crossbedded to massive pebble/cobble gravel, the largest clasts of which are medium-sized cobbles. This pit is 1.5 km upstream from Stop 10, but sediment in it is considerably coarser grained than that at Stop 10. The depositional gradient here was about 3 m/km, whereas that in the vicinity of Stop 10 was 2.6 m/km. Collapse depressions, now filled by swamp deposits, indicate that isolated large blocks of ice were buried in this part of the outwash deposit.

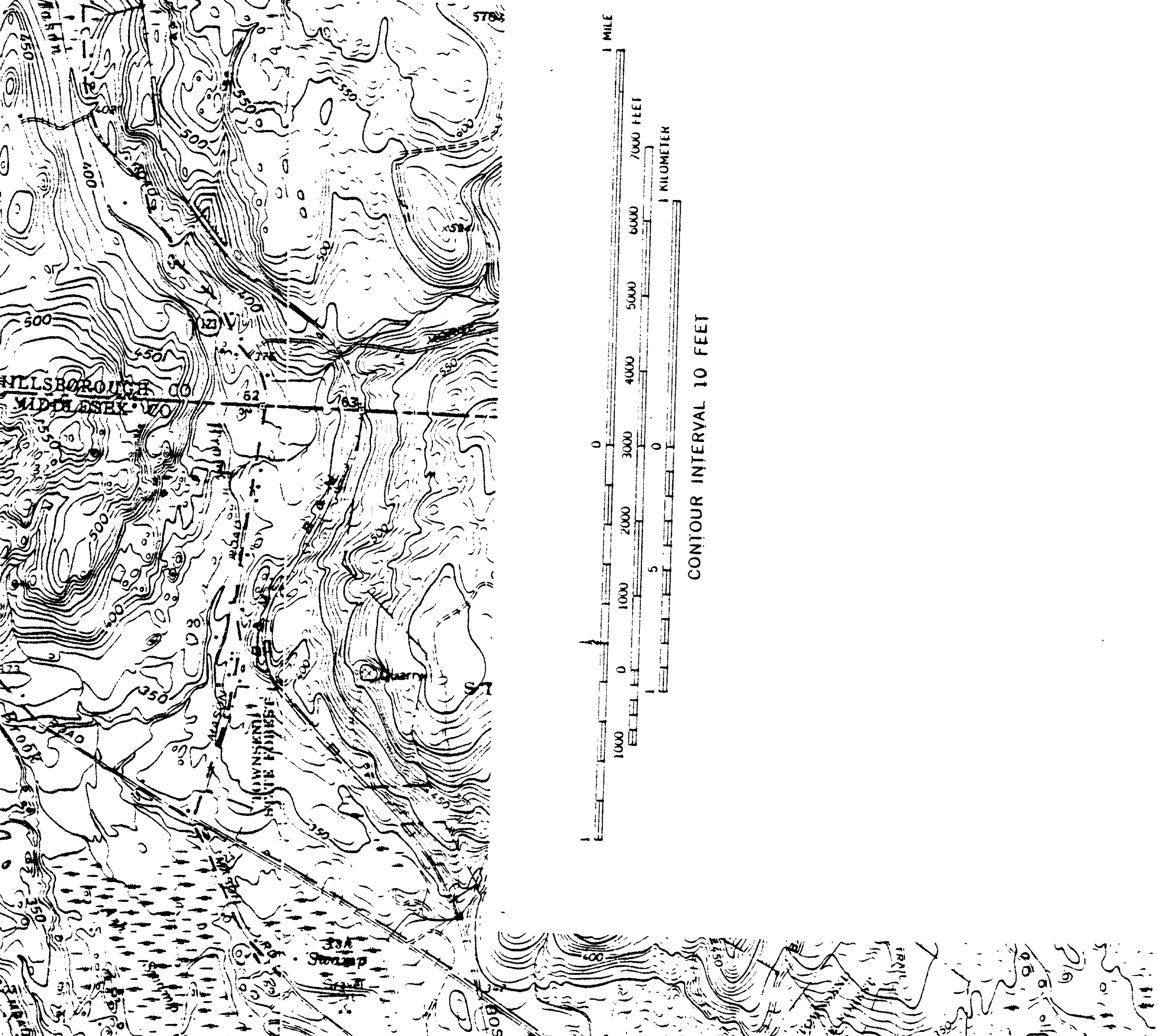


Figure 10.--STOPS 10 and 11, Topography from U.S. Geological Survey maps of the Ashby and Townsend 7 1/2′ quadrangles, Massachusetts and New Hampshire.

STOP 12: WILLARD BROOK DELTAIC DEPOSITS

The large pit at Stop 12 (fig. 11) exposes about 25 m of an ice-contact delta that was built into a small upland ice-marginal lake in this north-draining basin. The vertical sequence of textures and structures characteristically coarsens upward. Lower delta foreset beds, about 10 m thick, consist of interbedded sets of flat beds and ripple-drift cross-laminations, and local lenses of pebble gravel. Lower foresets dip less than 10°. Overlying these lower foresets are 10 m of sand and granular to pebbly sand in interbedded sets of flat beds and ripple-drift cross-laminations. The uppermost foreset beds, 3 m thick, consist of coarse, granular sand, pebbly sand, and pebble gravel. These beds dip southerly about 25°. Topset beds consist of pebble-cobble gravel but a few are of sand.

At the north end of the pit, exposures show collapsed proximal foreset beds which are chiefly sand interbedded with flat and rippled beds and cobble and pebble gravel; the gravel locally contains a coarse sand matrix without interstitial fines. The entire deposit can be characterized by three map units based on texture: sand, which composes the distal dip slopes of the delta; sand and gravel/sand, for the central part of the delta; and mixed sand and gravel, for the collapsed, ice-contact head of the delta. Knowing the depositional setting and morphology of the deposit, could one predict these textures?

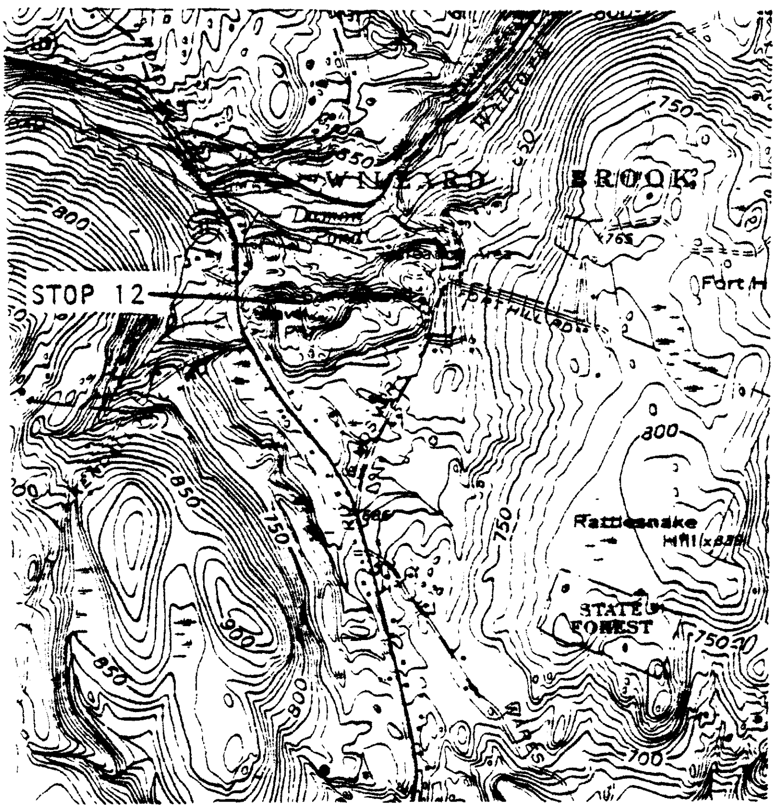


Figure 11.—STOP 12, Topography from U.S. Geological Survey map of the Ashby 7 1/2′ quadrangle, Massachusetts and New Hampshire.

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 10 FEET

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SATURDAY ROADLOG (MAY 16, 1981)

Miles	Accum. Miles	
0		Holiday Inn lower lot. Turn left onto Route 12, then an immediate right onto Route 2 east.
1.9	1.9	Exit Ramp, Interstate Route 190 south.
5.6	7.5	Int. Route 190 ends, Turn left (south) onto Route 12.
6.9	14.4	Intersection with Route 140, the "Triangle."
1.1	15.5	Intersection of Route 140 and Thomas Street, Oakdale Village; turn left.
0.4	15.9	Intersection of Thomas Street and River Road, turn right.
1.6	17.5	Entrance, Holden Town Sanitary Landfill. STOP 1.
—	17.5	Landfill entrance, turn left, retrace route to the "Triangle."
1.6	19.1	Thomas Street, turn left.
0.4	19.5	Route 140, turn right.
1.1	20.6	The "Triangle," Wachusett Reservoir, West Boylston. STOP 2.
—	20.6	South on Routes 140 and 12.
0.9	21.5	West Boylston Center, bear left on Route 140.
2.6	24.1	Boylston Stage of Lake Nashua outlet on the right; discussion at Stop 3.
0.3	24.4	Intersection with Route 70, turn left onto Route 70.
5.3	29.7	Intersection at Clinton Town Line with Willow Road, turn right.
0.5	30.2	Berlin Town Line.
0.1	30.3	Entrance to Rattlesnake Hill Spillway, turn right. Mileage suspended here. Busses will turn around at Golas house at end of the lane. STOP 3. Rattlesnake Hill Spillway, outlet for Clinton stage, Lake Nashua.
—	30.3	Willow Road, proceed east toward Berlin.
0.7	31.0	Lincoln Road, West Berlin, turn left.

Miles	Accum. Miles	
0.1	31.1	West Street, turn left.
0.1	31.2	Randall Road, turn right, cross railroad tracks.
1.0	32.2	Peach Street, bear left.
1.0	33.2	Bolton Town line.
0.3	33.5	Sawyer Road, bear left.
0.6	34.1	Wataquadock Hill Road, stop sign, continue across.
0.4	34.5	Ballville Road, bear right.
0.9	35.4	Intersection of Old Bay and Wilder Roads, proceed straight on Wilder Road.
1.1	36.5	Route 117, make sharp left turn (northwest).
1.5	38.0	Bolton Orchard Store, turn left into parking area, STOP 4.
—	38.0	Intersection of Routes 110 and 117, proceed west on Route 117.
0.4	38.4	Lancaster Town Line.
0.4	38.8	Nashua River.
0.6	39.4	Railroad tracks, Harvard Road immediately west, turn right (north).
0.4	39.8	Pine Hill Road, turn right. Watch for trucks hauling sand and gravel.
0.4	40.2	Gate, Pine Hill Sand and Gravel pit. STOP 5.
—	40.2	Return to Route 117.
0.8	41.0	Route 117, turn right (west).
0.5	41.5	North Village, continue on Rte 117.
0.2	41.7	Pipeline Road, turn right (north) toward Fort Devens.
3.2	44.9	Mechanics Street Ramp, turn right onto Route 2 East.
3.1	48.0	Exit on ramp to Fort Devens.

Miles	Accum. Miles	
0.6	48.6	Entrance to Fort Devens. Fort Devens Sanitary Landfill, STOP 6.
——	48.6	Mileage resumed at main gate on the north side of Fort Devens. Turn right (east) onto West Main Street, Ayer.
1.2	49.8	Ayer Village, turn left (north) onto Routes 2A and 111.
0.6	50.4	Bear right on Route 111.
1.0	51.4	Groton Town line.
1.0	52.4	Groton School.
0.8	53.2	Intersection with Route 225, continue straight ahead.
0.5	53.7	Intersection with Route 119, Groton, bear left (north).
0.2	53.9	Stop sign, turn left (northwest) on Routes 111 and 119.
1.4	55.3	Nashua River.
0.4	55.7	River Road, turn right (north) on Route 111.
2.8	58.5	Rotary, proceed around and go west on Route 113.
0.5	59.0	Park Street, Pepperell Center, turn right (north).
0.9	59.9	Prescott Street, bear right.
0.3	60.2	Melt-water channels, Twin Valley Farm. STOP 7.
0.1	60.3	Brookline Street, turn right (east).
1.2	61.5	Stop sign, Route 111. Turn left on Route 111 east.
0.1	61.6	Turn right on Route 111 (east).
2.8	64.4	New Hampshire State Line, enter Hollis.
0.7	65.1	Depot Road, turn left (north).
0.5	65.6	Hollis Sanitary Landfill. STOP 8.

RETURN TO LEOMINSTER

SUNDAY ROADLOG (May 17, 1981)

Miles	Accum. Miles	
0	0	Holiday Inn, Leominster, parking lot entrance proceed straight (east) on Hamilton Street.
1.0	1.0	Route 13, turn left (north).
0.1	1.1	Prospect Street, turn right.
0.9	2.0	Harvard Street intersection, bear left.
0.4	2.4	Entrance, Jocelyn Hill sandpit, turn left. STOP 9.
—	2.4	Return to pit entrance, Prospect Streeet, turn left.
0.6	3.0	Lancaster Avenue, turn left.
4.4	7.4	Lunenburg Center, proceed straight across Route 2A.
0.3	7.7	Highland Street, bear left.
1.1	8.8	Northfield Road, turn left.
0.1	8.9	West Townsend Road, turn right.
0.3	9.2	Route 13, turn right.
4.4	13.6	Townsend Center, Route 119, turn left (west).
1.9	15.5	Canal Street, turn right.
0.1	15.6	Squannacook River.
0.1	15.7	Dudley Road, turn right.
0.5	16.2	Turnpike Street, bear right.
0.2	16.4	Entrance to sandpit, turn right. STOP 10.
—	16.4	Return to pit entrance, Turnpike Street, turn left.
0.2	16.6	Dudley Road, proceed straight on Dudley.
0.5	17.1	Mason Road, turn right.
0.3	17.4	Entrance, sand and gravel pit, turn left. STOP 11.
—	17.4	Return to pit entrance, Mason Road, turn left.

Miles	Accum. Miles	
0.4	17.8	Roadcut exposures right and left, note cobble size.
0.5	18.3	Road intersection, turn around and retrace route southeast on Mason Road.
1.4	19.7	Route 119, turn right.
3.3	23.0	Route 31, turn left (west).
0.1	23.1	Route 31 South, turn left.
0.2	23.3	Entrance to sand and gravel pit, turn left. STOP 12.
—	23.3	Return to pit entrance, Route 31, turn left (south).

RETURN TO LEOMINSTER
via Route 31 South to Fitchburg
connect with Route 12 south to
Leominster