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Surficial Geology of the Rochester 7.5-minute Quadrangle, York County, Maine

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INTRODUCTION

The Rochester 7.5-minute topographic quadrangle is located along the Maine-New Hampshire border in southwestern Maine. The principal town, Rochester, is approximately 20 miles north of Kittery, Maine. The area lies within the Seaboard Lowland physiographic province, where altitudes range from sea level to 600 feet above sea level. The area is drained by the Salmon Falls River and its tributaries, which include Little River and Great Brook. The Salmon Falls River reaches the coast at Kittery.

During the last (Wisconsinan) episode of glaciation, ice advanced from the northwest across the area to a terminal position on the continental shelf. Glacial erosion produced a distinct northwest-southeast topographic lineation. Streamlined erosional features are common, and several valleys paralleling the direction of ice movement display the effects of erosional deepening and steepening. Glacial deposition resulted in a general reduction of preglacial relief by preferential infilling of valleys. This effect is most pronounced in that portion of the area below the limit of late-glacial marine submergence.

Ice retreat, accompanied by marine submergence, progressed rapidly across southwestern Maine in a general northwesterly direction. End moraines and composite deltas and fans were produced at or near the ice front during the period of retreat, and outline the pattern of ice withdrawal from the region.

Original mapping of the Maine portion of the Rochester quadrangle was conducted by Bloom (1960) at a reconnaissance level (1:62,500; 1:125,000). The area was remapped by Smith (1977) at a scale of 1:62,500 in the early stages of the Maine Geological Survey's reconnaissance mapping program. More detailed mapping of portions of the Rochester quadrangle was undertaken in the several stages of the Survey's aquifer mapping program (D. W. Caldwell in Caswell, 1979; Tolman and others, 1983). The surficial geology of the part of the Rochester quadrangle lying in Maine was revised and updated for the present study during the 1989 field season. Koteff (1991) has mapped the New Hampshire portion of the quadrangle.

Information bearing on the stratigraphy and glacial geologic history of this portion of Maine can be found in the following publications: Bloom, 1960, 1963; Smith, 1981, 1982, 1984, 1985, 1989. Publications by Thompson (1978, 1982), Stuiver and Borns (1975), and Thompson and Borns (1985) provide helpful general references to the glacial geology of the entire coastal zone.

GLACIAL AND POSTGLACIAL PROCESSES

The general succession of glacial and postglacial deposits in the coastal lowland of York County is presented in Tables 1 and 2 and Figure 1. All glacial deposits in the area are ascribed to the Late Wisconsinan glacial episode. Deposits exposed above the marine limit record both glacial advance and retreat, while most sediments exposed below the marine limit are related to deglaciation and late glacial marine submergence.

Glacial Till (Pt)

Glacial till occurs throughout the mapped area, both above and below the marine limit. The thickness of the till is variable, as is its composition. Till occurs in a variety of genetic types, including lodgement till, flow till, and melt-out till. Both above and below the marine limit, lodgement till forms a blanket deposit over topographic highs and is inferred to underlie younger deposits in topographic lows. This till is typically a bouldery, gray, compact material, with a sand-silt-clay matrix. Locally, thicker accumulations of lodgement till have been streamlined to form drumlins.

TABLE 1. TIME/SPACE RELATIONSHIPS OF GLACIAL MATERIALS IN YORK COUNTY*

	Glacial	Glacial Fluvial	Glacial Marine	Fluvial	Wetland	Marine
HOLOCENE				**Ha** **Hst**	**Hws** **Hwh**	Hms Hwsm
PLEISTOCENE LATE WISCONSINAN	Pt	**Pgo** **Pmd** **Pgi** Pmdi **Pge** Pfemc Pemc Pem	Pms **Pmrs** Pp Pm			Pmn

* Units that occur in the Rochester quadrangle are shown in boldface type.

Ice-Contact Stratified Drift (Pgi, Pge)

Ice-contact stratified drift occurs in a variety of forms in the Rochester quadrangle. Valley-side (kame terrace) ice-contact deposits are mapped within the valley of the Salmon Falls River. Some of these deposits probably are the eroded remnants of glaciomarine deltas, corresponding to more extensive deltaic deposits mapped on the New Hampshire side of the river by Koteff (1991). Northern portions of the quadrangle contain extensive deposits of ice-contact gravels related to esker sedimentation and ice stagnation in the uplands above the marine limit.

Glacial Outwash (Pgo) and Deltaic Deposits (Pmd)

Glacial outwash consists of sand and gravel deposits that occur as valley fills. These sediments were deposited by glacial meltwater streams in a proglacial setting as ice retreated. Technically speaking, the glacial marine deltas can be considered to be outwash deposits. However, for the sake of clarity in the presentation of map units, the deltas were considered to be separate depositional entities.

Presumpscot Formation (Pp) and Marine Sand Deposits (Pmrs)

The Presumpscot Formation includes clayey to silty glacial marine sediments that are widely distributed in Maine's coastal lowland. Only the sandy regressive marine deposits, which were graded to a falling relative sea level, outcrop in the present study area. This unit (Pmrs) occurs in the Salmon Falls River valley.

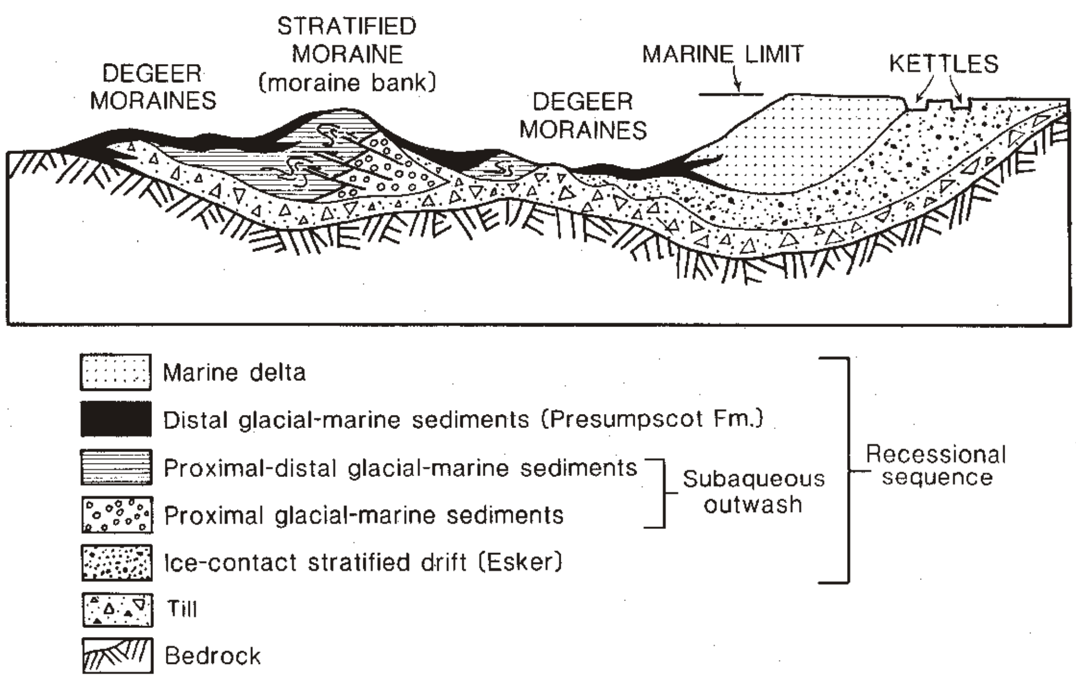

Figure 1. Generalized stratigraphy of Late Wisconsinan glacial deposits of coastal Maine (from Smith, 1985)

TABLE 2. DESCRIPTION OF MAP UNITS*

SYMBOL	UNIT	DESCRIPTION
Ha	Stream alluvium	Gray to brown fine sand and silt with some gravel. Comprises floodplains along present streams and rivers. Extent of alluvium approximates areas of potential flooding.
Hst	Stream terrace deposits	Sand and gravel deposited on terraces cut by postglacial streams.
Hws	Wetland, swamp	Muck, peat, silt, and sand. Poorly drained areas, often with standing water.
Hwh	Heath	Peat and fine-grained inorganic sediment. Distinguished from other wetlands by the absence of trees and the presence of shrubs.
Hwsm	Wetland, saltmarsh	Muck, peat, silt, and sand. Coastal settings subject to tidal fluctuation.
Hms	Marine shoreline deposit, beach	Sand, some gravel and minor silt. Coastal settings of active beach construction.
Pmn	Marine nearshore deposits	Areas of till that have been reworked by the sea during regressive phase of marine submergence. Till has had finer constituents (silt and sand) removed and redeposited as thin veneer over till. Bedrock commonly at shallow depth. Average thickness probably less than 3 m. Locally, this unit may include marine clay and sand, as well as isolated boulders. Originally mapped as Pwts (washed till and sand).
Pms	Marine shoreline deposit	Predominantly sand with minor gravel. Beach deposits formed during period of stillstand in regressive phase of marine submergence. Thickness variable from less than 3 m in beach ridges to more than 10 m in aprons around eroded drumlins.
Pmrs	Regressive marine sand deposits	Massive to stratified and cross-stratified, well sorted brown to gray-brown sand. May have gradational basal contact with Pp. Thickness between 1 and 5 m. Deposited during regressive phase of marine submergence.
Pp	Presumpscot Formation (silt/clay facies)	Massive to laminated gray and blue-gray (weathering to brown) silt and silty clay. Locally may contain boulders, sand, gravel. Occurs as blanket deposit over bedrock and older glacial sediments. Variable thickness from less than 1 m to more than 50 m. Deposited during period of late-glacial marine submergence.
Pm	Marine deposits (undifferentiated)	Pp and/or Pmrs deposits mapped in areas of poor access or poor exposure, or where both units occur as areas too small to be mapped separately. Thickness variable within range described for Pp and Pmrs.
Pgo	Outwash	Sand, gravel, and minor silt deposited by glacial streams in a proglacial (away from ice) setting. Generally confined to river valleys. Sometimes terraced. Average thickness probably between 5 and 10 m.
Pmd Pmdi	Marine delta	Coarse sand and gravel grading to sand and silt. Flat to gently sloping constructional surface formed by glacial streams discharging into late glacial sea. Heads of deltas are commonly kettled (Pmdi) and mark ice frontal positions. Sediments in distal portions of deltas commonly grade into glacial marine sediments (Pp, Pmrs). Variable thickness from more than 30 m at delta head to less than 1 m at delta toe.
Pgi	Ice-contact deposits (undifferentiated)	Coarse gravel and sand. Primarily kettled glacial stream deposits in the immediate vicinity of eskers (Pge). Average thickness probably between 10 and 15 m.
Pge	Esker	Coarse gravel and sand comprising distinct linear ridges, mostly in valleys. Generally surrounded by Pgi deposits, and terminating in ice-contact deltas. May be more than 10 m thick.
Pfemc	Fan-end moraine complex	Composite designation incorporating elements of end moraines and subaqueous fans. Coarse to fine sand and gravel extending from fan head to fan toe. This material overlies sediments of end moraines and end moraine complexes. Refer to Figure 2.
Pem	End moraine	Coarse gravel and sand, locally includes till and silt. Generally occurs in areas of glacial marine sediments (Pp, Pmrs), and is complexly interstratified with them. Formed at or near the ice front during retreat of marine-based glacier. Sediments commonly display significant deformation. Typically 5 to 10 m thick.
Pemc	End moraine complex	Coarse gravel, sand, till, and silt; commonly over shallow bedrock. Mapped in areas of closely spaced small (DeGeer) end moraines. Formed at or near ice front during retreat of marine-based glacier. Sediments commonly display significant deformation. Generally less than 5 m in thickness.
Pt	Till	Gray to gray-brown poorly sorted mixture of silt, sand, pebbles, cobbles, and boulders. Forms a blanket deposit over bedrock, and is inferred to underlie younger sediments where not exposed at surface. Thin over topographic highs; thickens in topographic lows. May occur in and over end moraines (Pem, Pemc). Averages 3 to 5 m in thickness.
rk	Bedrock	Rock units not distinguished. Individual outcrops not shown in large areas of poor access. Ruled pattern indicates areas where surficial materials are thin (less than 3 m) and bedrock exposures are common. Areas of bedrock exposure (solid color) are mapped in part from aerial photographs.

* These units are regionally distributed across York and Cumberland Counties. Only the ones in boldface type occur in the Maine portion of the Rochester quadrangle.

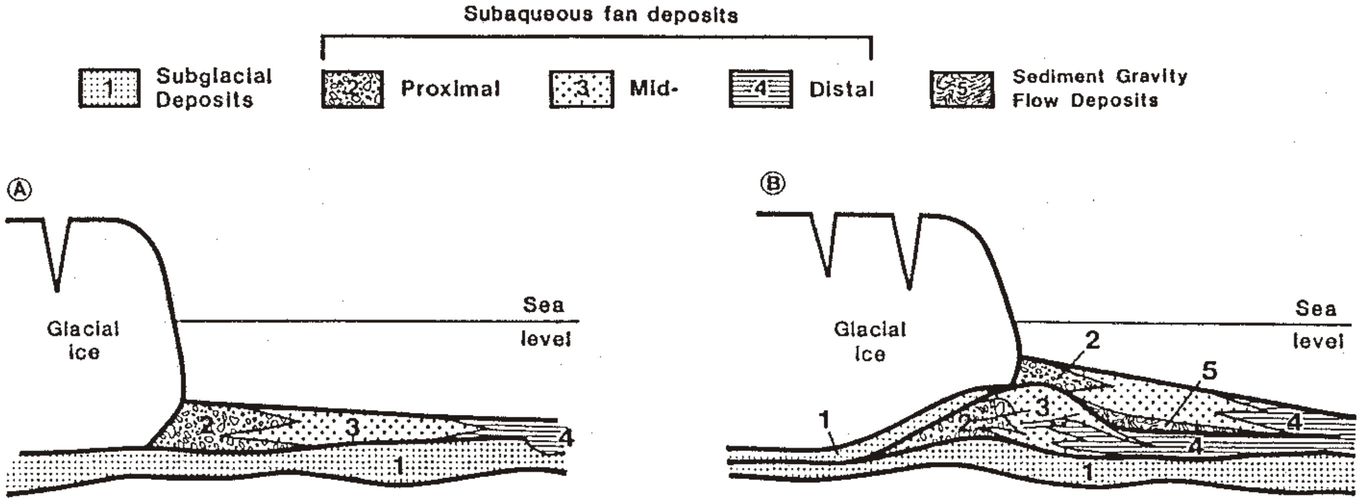

Figure 2. Stratigraphic relationships of subaqueous fan association (a) and subaqueous end moraine association (b). The simple stratigraphic situation of the subaqueous fan association is complicated during minor glacial readvance by glacial-tectonic deformation and thickening of the sedimentary package to produce an end moraine (from Smith, 1989).

Deposits of Wetlands and Modern Streams (Ha, Hst, Hws, Hwh)

Deposits of wetlands and modern streams have been mapped throughout the Rochester quadrangle. They are most significant in areas of relatively thin sediment cover and in areas adjacent to modern streams. They comprise swamps (Hws), heaths (Hwh), and local occurrences of stream terrace deposits (Hst) and floodplain alluvium (Ha). In some cases, the swamps and heaths are further differentiated according to thickness of peat deposits.

GLACIAL AND POSTGLACIAL HISTORY

All glacial deposits found in the Rochester-Somersworth area have been ascribed to the last (Late Wisconsinan) glacial episode to affect coastal Maine. The oldest deposits thus far recognized in the coastal zone are those exposed in coastal cliffs at and near Great Hill (Wells quadrangle), east of Rochester (Smith, 1985). The deposits at Great Hill are thought to record the advance and retreat of the last ice sheet to and from its terminal position on the continental shelf east of the present coastline. In all likelihood, deposits of till in the Rochester area record the same event, and stratified sediments record retreat of this last ice from the coastal zone in a marine setting.

The orientations of drumlins and other streamlined forms, as well as the orientations of glacial striations, indicate that the last ice to cover the area advanced from the northwest. Local divergence from this general trend resulted from topographic control on the pattern of ice flow.

Withdrawal of Late Wisconsinan ice from its terminal position was underway between 17,000 and 15,000 years ago, and the glacier margin had retreated across the Gulf of Maine to a position roughly parallel to, but some distance offshore of, the present coastline by 14,000 years ago (Smith, 1985). Dates on shells collected from the Wells-Kennebunk area indicate that ice remained in the vicinity of the southwestern Maine coastal zone until 13,200 years ago.

Two indirect effects of glaciation had a very strong bearing on the character of ice retreat and the deposition of glacial sediments in this portion of the coastal zone. First, the great weight of ice depressed the crust beneath the glacier significantly below its present level throughout the region. Secondly, as the glacier expanded, water was trapped on land as ice, and sea level, as a result, was lowered by several hundred feet. As ice began to melt and retreat, water was returned to the ocean and sea level rose immediately. At the same time, the crust began slowly to rebound to its original level. The interaction of these two effects resulted in submergence of the entire Maine coastal zone for a period of several hundred years following retreat of ice. Furthermore, during its retreat, the glacier was grounded in the sea, so that a complex assemblage of glacial marine sediments was deposited over the area below the marine limit (Figure 3).

As ice began to retreat in a general northwesterly direction across the Rochester area, coarse clastic sediments (till and ice-contact stratified drift) accumulated adjacent to the ice front, while fine sediment (silt and clay of the Presumpscot Formation) was deposited further away from the ice in nearby parts of coastal Maine and New Hampshire (Figure 3).

During the period of ice retreat, at least while ice was marine-based, it remained active and continued to advance periodically over short distances. These advances resulted in deformation of previously deposited sediments (Figure 2) and construction of minor (DeGeer) moraine ridges. During periods of extended stillstand, sediments accumulated at the ice front (or grounding line) to form larger end moraines, subaqueous fans,

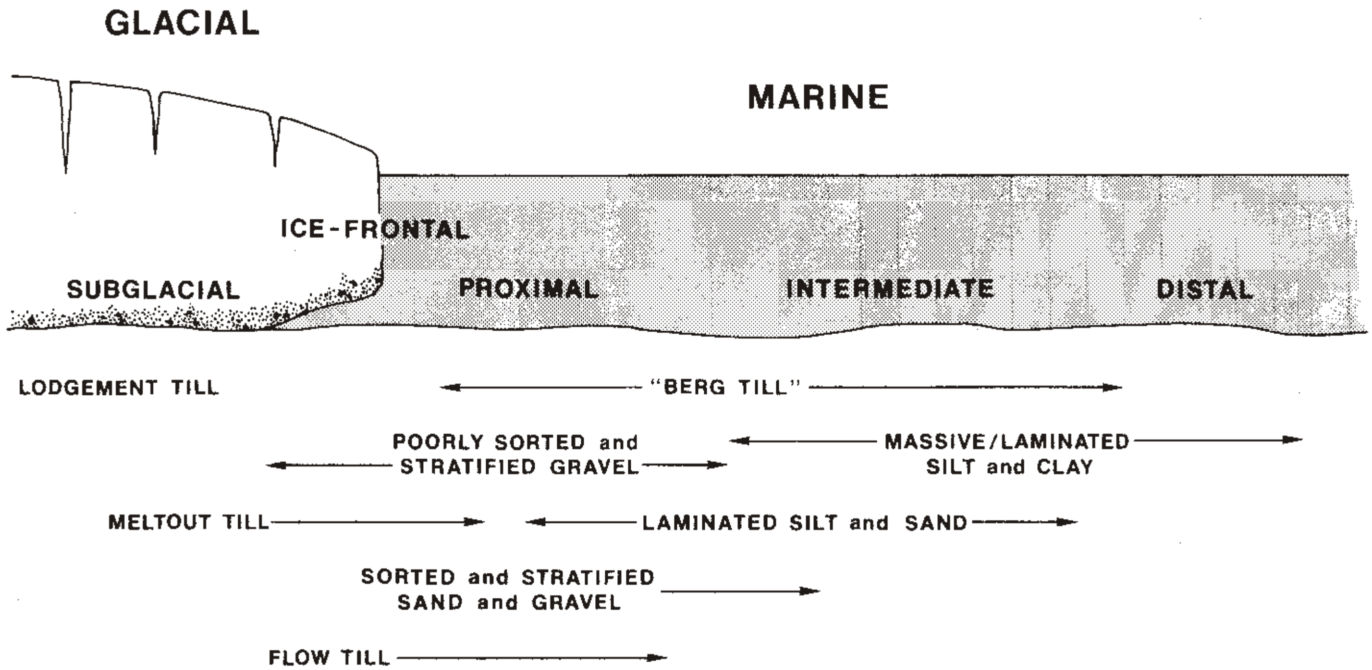

Figure 3. Glacial marine facies associations for the Maine coastal zone (from Smith, 1984).

and partial or complete deltas. Of these various types of deposits found in coastal Maine, only deltaic sediments occur in the study area.

Deposits of ice-contact stratified drift (Pgi, Pge) occur in a variety of geographic and sedimentological settings. The most extensive of these deposits occur in the valleys of the Salmon Falls River, Keay Brook, and Little River. These materials are generally associated with ice stagnation and esker sedimentation.

Ice-contact sand and gravel has been mapped along the eastern valley side of the Salmon Falls River between South Lebanon and North Rochester. These deposits occur as kame terraces (Pgi) and as a discontinuous cover of gravel and till (Pgi & Pt), which probably represents materials deposited in ice-marginal channels during withdrawal of ice from the valley. As noted above, at least some of the poorly exposed kame terrace (Pgi) unit near North Rochester probably correlates with glacial marine deltaic deposits across the river in New Hampshire. The Pgi deposits on the east side of the valley reach the same elevation (about 250 feet) as the upper marine limit recorded by a delta near North Rochester (Koteff, 1991).

Sorted ice-contact sediments (Pgi) occur in close association with a major esker system (Pge) in the valley of Keay Brook. The esker heads north of the Rochester quadrangle and ends in a series of meltwater channels and collapsed ice-contact sediments in the east-central portion of the quadrangle. Valley-side ice-contact deposits extend southward from this position as terraces and veneer against the eastern side of the Salmon Falls River valley. The esker that served as the principal source of these sediments can be traced for a considerable distance north of the Rochester quadrangle, and may extend southeastward into the Somersworth quadrangle through Long Swamp Road, and then into the Little River valley in the vicinity of Stackpole Bridge. In all likelihood, ice-contact sediments related to this esker system underlie, or are interbedded with, the extensive deltaic (Pmd) apron that fills the east side of the Salmon Falls River valley between Berwick and South Lebanon.

Well sorted proglacial deltaic and related deposits (Pmd, Pgo, and Pmrs) may well comprise the most important group of sediments in the Rochester area. These deposits are most extensive in the Salmon Falls River valley southeast of South Lebanon. They consist of relatively clean, well stratified sand and gravel. This unit is a good potential ground-water aquifer and a very reliable source of construction aggregate. It is clearly to be avoided as an area for waste disposal.

The meltwater deposits in the Salmon Falls River valley had several sources. Some sediment appears to have been provided from the esker system within the valley of Keay Brook. It is likely that additional sediment was supplied by fluvial deposition in the Salmon Falls River valley. However, the principal source of this extensive valley fill is Great Brook, which enters the Salmon Falls River valley at Blaisdell Corners. Meltwater from stagnating ice north of the Rochester area discharged via a major overflow channel into Great Brook, providing the bulk of sediment for construction of a delta heading in the Blaisdell Corner area. The contact between topset and foreset beds in this delta indicates that the contemporary sea level was 236 feet above its present position (Thompson et al., 1989).

The ice-contact deposits described above were deposited beneath or alongside ice in a terrestrial setting (mostly above the marine limit). Deltaic and outwash deposits were deposited in settings that ranged from ice marginal to distal proglacial, and are, thus, in part terrestrial and in part subaqueous. Commonly, the deltaic deposits mapped here (Pmd) topographically grade southward and eastward to the sandy marine regressive deposits (Pmrs). The contact between the latter units is not clearly defined, especially since these deposits have been eroded and terraced by postglacial stream activity. Thus, the contact shown on the map is approximately located.

As ice withdrew northwestward across the Rochester area, isostatic rebound began to elevate the land, and sea level began to fall. Meltwater streams may have continued to carry sediment to the ocean as sea level fell.

With continued lowering of sea level, materials deposited during earlier stages of glaciation and deglaciation passed through the wave zone and were eroded. Short-term pauses in the lowering of sea level allowed for incision of streams into older sediments, producing erosional scarps and stream terraces. Records of some of these events can be documented between the elevation of maximum marine submergence (236 feet asl) and the present sea level.

Following withdrawal of ice from the coastal zone and the completion of isostatic rebound, sea level became established at its present position. Streams were graded to this level and began to construct floodplains (Ha). Swamps and heaths developed in areas of elevated water tables and poor drainage.

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APPENDIX: ADDITIONAL SITE INFORMATION FOR MATERIALS MAP

Site No.	Description
4	Surface morphology indicates (constructional) terrace.
9	Flow indicators (crossbeds) S15E to S30E.
22-23	Sites 22 and 23 mark distal edge of outwash fill that extends southward along the Salmon Falls River, and appears to originate from the valley of Great Brook (at Blaisdell Corners). Site 22 is on the highest (240+ ft asl) outwash surface (terrace). A distinct scarp with 5-10 ft of relief separates site 22 from site 23.
33	Distinct surface at 250+ ft asl.
39	Till west of road. Bedrock exposed in Great Brook east of road.
53	Contact with esker gravel immediately east of site.
54	Pit in core of esker.
57-58	Surface morphology along Berwick Road (sites 57,58) indicates relatively thick till (streamlined molded till forms).
59	Distinct SSW-trending ice-marginal channels.
60	Ice-marginal channels.
63	Esker margin.
75	Distinct constructional surface at 240+ ft asl. Terraces to west of road in valley of Great Brook indicate incision of outwash surface probably related to lowering of sea level (or isostatic adjustment).
76	Incision of outwash.
77	Incision of outwash.
78	Incision of outwash.
79	Incision of outwash.
86	Probable meltwater channel deposits (related to esker?).
90	Probably loess over till against valley side.
93	Incision of outwash.
95	Terraces.