NATIONAL GEOLOGICAL MAPPING PROGRAM

206 22-9590

113 22-5966 no log, 10 feet to bedrock

115 22-18675 no log, 10 feet to bedrock

116 22-19411 no log, 25 feet to bedrock

120 22-18350 no log, 28 feet to bedrock

121 22-20905 no log, 32 feet to bedrock

124 22-19710 no log, 10 feet to bedrock

122 22-21642 0-33 clay and gravel (Qn)

126 22-19209 0-61 clay and gravel (Qn)

127 22-19749 0-30 clay and gravel (Qn)

129 22-18225 0-35 clay and gravel (Qn)

130 22-18797 0-45 clay and gravel (Qn)

131 22-18226 0-11 clay and gravel (Qn)

132 22-21458 0-153 clay and gravel (Qn)

134 22-18358 0-28 clay and hardpan (Qn)

135 22-19413 0-48 clay and gravel (Qn)

137 22-21307 0-30 clay and gravel (Qn)

138 22-18224 0-27 clay and gravel (Qn)

139 22-18126 0-22 clay and gravel (Qn)

140 22-22076 0-106 clay and gravel (Qn)

143 22-21931 0-72 clay and gravel (Qn)

144 22-21932 0-107 clay and gravel (Qn)

145 22-21930 0-120 clay and gravel (Qn)

146 22-21977 0-90 clay and gravel (Qn)

148 22-21089 0-60 clay and gravel (Qn)

152 22-20541 no log, 11 feet to bedrock

156 22-20995 0-24 clay (Qn)

158 22-21175 no log, 29 feet to bedrock

161 22-9303 no log, 73 feet to bedrock

165 22-21789 no log, 2 feet to bedrock

153 22-18071 0-40 clay and gravel (Qn)

clay and boulders (Qn)

soft rotten rock

147 test boring 0-9

149 22-18269

150 22-20319

164 22-8868

175 22-10024

177 22-9551

178 22-9375

181 22-18991

boulders and clay (Qn)

100-115 gray sand 115-120 clay (47-120 weathered gneiss)

117 22-19023 0-8 clay (Qn)

118 22-18349 0-14 clay (Qn)

123 22-19333 0-15 clay (Qn)

125 22-19607 0-20 clay (Qn)

128 22-18795

133 22-21233

136 22-1176

114 22-19216 no log, 54 feet to bedrock (this thickness

ned in sand above bedrock, interval

43 22-22868 0-4 fill (Qnc3)

44 22-19448 0-22 sand and gravel (Qnc3)

46 22-7620 no log, 10 feet to bedrock

47 22-18388 no log, 3 feet to bedrock

48 22-18527 no log, 22 feet to bedrock

49 22-18676 no log, 25 feet to bedrock

50 22-19276 no log, 15 feet to bedrock

51 22-18551 no log, 5 feet to bedrock

52 22-21623 no log, 15 feet to bedrock

55 22-20450 0-14 clay (Qk)

7 22-18222 0-5 clay (Qk)

58 22-18223 0-11 clay (Qk)

59 22-20005 0-25 clay (Qk)

60 22-21058 0-6 clay (Qk)

1 22-20452 0-23 sand and gravel (Qst)

63 22-20975 0-52 sand and gravel (Qhm)

66 22-22014 0-35 sand and gravel (Qwk)

67 22-22015 0-36 sand and gravel (Qwk)

70 22-19871 0-106 sand and gravel (Qwk)

71 22-19469 0-22 clay and gravel (Qk)

76 22-21132 0-34 clay and hardpan (Qk)

77 22-19189 0-16 clay overburden (Qk)

78 22-21488 0-6 clay overburden (Qk)

82 22-19944 0-6 clay overburden (Qk)

86 22-19120 0-75 sand, gravel, hardpan (Qk)

89 22-21011 0-8 clay overburden (Qk)

91 22-11860 0-100 sand and gravel (Qwkd)

93 22-21504 0-91 sand and gravel (Qwkd)

94 22-18742 0-25 clay and gravel (Qk)

92 22-20466 0-4 clay (Qwkl)

95 22-20422 0-28 clay (Qk)

98 22-18133 no log, 15 feet to bedrock

99 22-21230 no log, 14 feet to bedrock

0 22-20309 no log, 8 feet to bedrock

02 22-21791 no log, 5 feet to bedrock

03 22-19983 no log, 8 feet to bedrock

04 22-20609 no log, 3 feet to bedrock

106 22-21568 0-30 clay and gravel (Qn)

105 22-18220 0-2 clay (Qn)

no log, 4 feet to bedrock

96 22-21459 0-3 clay (Qk)

97 test boring 0-7

90 22-11856 0-10 sand and gravel overburden (Qwkd

0-6 overburden (Qwk) 6-20 soft slimy gray clay (Qwkl)

dark yellowish brown coarse sand

gray silty clay (unoxidized Qwl

79 22-21746 no log, 17 feet to bedrock

80 22-21896 no log, 9 feet to bedrock

81 22-21894 no log, 6 feet to bedrock

83 22-21895 no log, 5 feet to bedrock

84 22-18537 no log, 50 feet to bedrock

85 22-21685 no log, 4 feet to bedrock

68 22-15412 0-28 gravel (Qwk)

72 22-11478 0-6 clay (Qk)

64 22-21335 0-48 sand and gravel (Ql over Qhm)

65 22-21237 0-41 clay and gravel (Qs overlying Qk)

3 test boring 0-9 yellowish brown laminated silt ar

0-23 sand and gravel (Qst)

0-5 earth and clay (Qk)

cooperation 9-36 gray laminated silt, clay, and with the U. S. gray laminated silt, clay, and very fine sand (unoxidized O

0-52 clay and gravel (Qwk)

pebbles and cobbles in a yellow

62 22-21051 0-46 clay and gravel (Qal overlying Qhm)

56 22-20303

69 22-25

4 22-20503

5 22-3408

88 22-11814

53 22-20174 0-65 clay and gravel (Qk)

54 22-21554 0-34 clay and gravel (Qk)

overburden clay and gravel (Qk)

45 22-19447 0-55 sand and gravel (Qnc3)

INTRODUCTION

NEW JERSEY GEOLOGICAL SURVEY

generally less than 20 feet thick.

The accompanying map and cross sections show the surface extent and subsurface relations of these deposits. A brief summary of their resource and environmental characteristics is provided below. Table 1 lists water-well and test-boring logs used to plot bedrock-surface opography and to infer the subsurface distribution of the deposits. Table 2 lists the composition of pebbles in the glacial sediments. The correlation chart shows the temporal relationships of the deposits. Figure 1 shows recessional ice margins, shorelines of glacial lakes, and the extent of recessional glacial deposits.

The stratified glacial sediments are divided into units that represent the glacial-lake basin or glacial-stream valley in which they were deposited. Numbers on the map units indicate successively lower lakes that formed as the ice front retreated (for example, Qnc1, Qnc2, Qnc3). The descriptions, and surface-texture patterns on the map, provide basic grain-size and thickness information for the stratified units. Bedding, color, and sorting are described in the general headings for each group of sediment.

Till is divided into two units based on color, texture, and gravel-clast composition. Moraines are mapped as morphologic varieties of these

RESOURCES AND ENVIRONMENTAL CHARACTERISITICS

Surficial deposits in the Hamburg quadrangle supply ground water to wells; influence the movement of water and pollutants from the land surface into lakes, streams, and underlying bedrock and glacial aquifers; and provide sand and gravel for construction uses. Glacial sediments yield ground water to domestic and public-supply wells at several places. Yields and screened intervals for these wells are provided in table 1. A few wells tap glaciolacustrine sand and gravel near North Church (wells 8, 9, 10, 12). Several industrial and publicsupply wells draw from glaciolacustrine sand and gravel near Hamburg (wells 31, 36, 40, 42). Similar deposits are also tapped in Vernon Valley (wells 175, 196, 203). In each of these three locations, water is withdrawn chiefly from lacustrine-fan deposits (units Qnc1, Qnc3, and Qma) that are overlain by fine-grained lake-bottom sediments. The lake-bottom sediments may act as a confining layer for the lacustrine-fan aquifers. Similar deposits are likely also present in the Wallkill Valley north of the junction with Papakating Creek, particularly below the 300-foot bedrock-surface contour. A few domestic wells also withdraw water from either till, sand and gravel buried beneath till, or weathered gneiss. Several wells east of Hardistonville (wells 17, 21, and 22) are completed either in till or in beds of sand and gravel within or beneath thick till. A number of wells on Pochuck Mountain (wells 128, 133, 136, 153, 154, 184, 185, 186, 190, 191) are completed within granular weathered gneiss.

Sand and gravel deposits are highly permeable (estimated hydraulic conductivity between about 100 and 1300 feet per day [ft/d]). Their outcrops may be recharge areas for glacial or bedrock aquifers. Sandy in these lakes mark ice-margin positions and lake elevations. As the and 100 ft/d). Silty to sandy silt till is moderately permeable (estimated hydraulic conductivity between 10⁻⁴ to 10⁻¹ ft/d). Lake-bottom sediment is of low permeability and will retard ground-water flow, particularly if clay is abundant (estimated vertical hydraulic conductivity of silty-clayey material is 10⁻⁵ to 10⁻³ ft/d; sandy-silty material is generally 10⁻³ to 10⁻¹ ft/d). The hydraulic conductivities cited here are based on aquifer-test and laboratory permeability data from glacial sediments in New Jersey, including published data summarized in Stanford and Witte (in press) and unpublished data on file at the N. J. Geological Survey (R. Canace, written communication).

Sand and gravel have been extensively mined from glacial delta and lacustrine-fan deposits. The location and extent of these mining operations are shown by the excavation-scarp symbols on the map. In places, for example, between McAfee and Hamburg, the mining has completely removed small deltas and lacustrine fans and the topography shown on the map (based on aerial photographs taken in 1951) no longer exists. Sand and gravel have also been mined from a few small pits in sandy till and in granular weathered gneiss on Pochuck Mountain. Locally, extraction may be hindered by carbonate cementation in gravel beds, and gravel quality may be affected by weathering of dolomite and gneiss clasts and by manganese and iron staining in shale-rich sand and gravel.

Peat and poorly consolidated, organic-rich silt and clay in alluvium and swamp deposits, and saturated silt, fine sand, and clay in lakebottom deposits, are of low strength and therefore are generally unsuitable supports for structures. They are also subject to flooding and high water tables. Areas of bedrock outcrop (gray pattern on map) and thin till (ruled pattern on map) have little or no soil cover overlying fresh bedrock. The use of septic systems may be severely limited in these areas, and blasting may be required for foundation excavation

GEOLOGIC SETTING

Bedrock in the quadrangle includes dolomite, shale, siltstone, sandstone, and minor limestone and quartzite of Ordovician and Cambrian age; and granite, gneiss, and marble of Precambrian age. The distribution of the major rock types is shown in figure 1. Pochuck Mountain and Hamburg Mountain are underlain by interlayered syenite gneiss, quartz-oligoclase gneiss, hornblende granite, amphibolite, biotite gneiss, and microcline gneiss (Hague and others, 1956; Baker and Buddington, 1970; Canace, unpub.). These rocks have a strong northeast-southwest foliation and strike and, on Pochuck Mountain east of Glenwood Lake and on Hamburg Mountain, they occur in broad plunging folds. The strike of the units controls the location of subsidiary ridges and valleys atop Pochuck Mountain and Hamburg Mountain. Long, sharp ridges on the east side of Pochuck Mountain reflect differential erosion of interlayered biotite gneiss and amphibolite; small arcuate ridges and valleys on the spur of Pochuck Mountain east of Glenwood Lake and larger arcuate uplands on Hamburg Mountain reflect differential erosion of units on fold noses.

Vernon Valley, the valley of the Wallkill River, and the valley of Beaver Run are underlain by carbonate bedrock. Cambrian and Ordovician dolomite (including minor sandstone and shale interbeds) of the Leithsville, Allentown, Rickenback, and Epler Formations, and Precambrian marble, underlie Vernon Valley and the lowland south and east of Hamburg (Canace, unpub.). The Beaver Run valley and the Wallkill valley north of Hamburg are underlain by Cambrian and Ordovician dolomite (including minor limestone, sandstone, and shale) of the Leithsville, Allentown, Rickenback, Epler, Ontelaunee, and Jacksonburg Formations (Canace, unpub.). These northeast-southwest trending belts of carbonate bedrock are the least resistant bedrock units in the quadrangle, and control the location of the major lowlands. Massive or chert-rich layers within the carbonate units form sharp, linear ridges.

The Beaver Run-Wallkill lowland is bounded on the west by an upland of northeast-southwest trending hills and ridges underlain by shale, siltstone, and sandstone of the Ordovician Martinsburg Formation. Sharp-crested strike-controlled ridges alternate with

PREGLACIAL DRAINAGE

Precise delineation of the preglacial drainage is locally complicated by glacial scouring in the carbonate units and by irregularities of the bedrock surface produced by preglacial or interglacial development of saprolite and, possibly, karst topography. Thicknesses of as much as 180 feet of weathered rock have been reported from water wells on Pochuck Mountain (Table 1, wells 184-186, 190, 191, 199, 200), and as much as 150 feet of possible collapsed carbonate saprolite and lacustrine sediment have been reported from water wells in karst terrain near North Church and in the northern part of Vernon Valley (Table 1, well 164). In addition, artificial cuts in a hillside about half a mile north of Lake Pochung on Pochuck Mountain expose at least 60 feet of granular decomposed gneiss overlain by 10 to 20 feet of till.

Modern drainage lines generally coincide with preglacial drainage. The Wallkill valley north of Hamburg is filled with as much as 120 feet of glacial sediment. Well data and locations of bedrock outcrop in this reach of the valley indicate that the axis of the buried valley beneath the present Wallkill slopes northward and in places is offset more than half a mile from the present river. At Hamburg and south of it, the Wallkill flows in a preglacial valley cut in bedrock, although a deeper buried preglacial valley may extend southward from Hamburg to North Church. In contrast, the valleys of Papakating Creek and Clove Brook are close to bedrock and contain a maximum of 40 or 50 feet of sediment.

Vernon Valley is filled with as much as 200 feet of sediment. Well data and outcrops indicate that the bedrock surface slopes northward from McAfee. The southward narrowing of this valley may have facilitated compressive ice flow and active erosion during glaciation, causing deep glacial scouring. Thus, the bedrock surface may be significantly altered from its preglacial configuration.

GLACIAL HISTORY

Glacial deposits in the Hamburg quadrangle are of late Wisconsinan age except in the cores of drumlins near Hamburg. Here, older till was observed in two excavations. It has a brown sandy silt matrix with some cobbles and few boulders. Both carbonate and crystalline clasts are completely decomposed to a depth of at least 10 feet, in marked contrast to the late Wisconsinan till, in which crystalline clasts are unweathered or have thin weathering rinds, and carbonate clasts are unweathered where they are abundant. Well data indicate that this older till may be as much as 100 to 150 feet thick within the drumlins (Table 1, wells 19-22, 24-26); but the till has not been observed, nor can it be inferred from well records, at any other location within the quadrangle.

Late Wisconsinan Ice Flow

Pre-late Wisconsinan Till

Most striations and drumlins in valleys trend between S10°W and S50°W, indicating valley-controlled ice flow during late Wisconsinan glaciation (figure 2). However, at higher elevations, where advancing ice was free of the valley walls, ice flow was more southerly. Striations on Hamburg Mountain indicate that ice flowed due south. Southward ice flow is also indicated by the pattern of plucked and abraded bedrock outcrops atop Hamburg Mountain. Smooth, gently sloping ledges abraded by glacial ice occur on north- and northwestfacing slopes; steep, blocky cliffs plucked by glacial ice occur on south- and southeast-facing slopes. In addition, belts of thick, continuous till occur preferentially on the northwest-facing slopes of uplands. Examples include the northwest side of Pochuck Mountain, the east sides of Vernon Valley and of the Wallkill valley south of Hamburg, and to a lesser extent, the southeast side of the Papakating valley south of Sussex. The lithology, topographic form, and location of these till ramps indicate deposition from ice flowing chiefly to the south.

Pebble and boulder lithologies in the till tend to confirm this southerly flow direction. Lithologies were counted at 31 sites in till throughout the quadrangle (table 2). Generally the counts indicate primary contribution from the local bedrock, and smaller contributions from bedrock units to the north and west. In the shale terrain in the northwest quadrant of the quadrangle, shale and sandstone content of the till ranges from 85 to 98 percent. Quartzite from the Shawangunk Formation, which crops out on Kittatinny Mountain 5 miles to the northwest, comprises most of the remainder of the samples. Carbonate and gneiss are absent or scarce.

outcrop belt of the Martinsburg Formation in the Wallkill valley north

Till in the lowlands has a more varied lithology. In Vernon Valley

carbonate clasts (including Precambrian marble) range from 0 to 77

percent of the total; the higher values are on the southeast side of the

valley. Gneiss content ranges from near 0 on the southeast to as

much as 77 percent adjacent to Pochuck Mountain. Sandstone and

shale content varies from 20 to 93 percent; the high values occur

adjacent to Pochuck Mountain and atop a shale and sandstone unit

In the carbonate lowland east and south of Hamburg till is continu-

ous and thick throughout much of the area. Gneiss dominates,

increasing from 22 percent of clasts in the west to 85 percent

adjacent to Hamburg Mountain. Shale and sandstone show a

corresponding decrease from 53 to 9 percent from west to east.

belt of the shale unit within the Leithsville Formation. This

belt extends from McAfee through Hamburg to Franklin (Canace,

unpub.) Carbonate content is unusually low, ranging from 18 to as

Thus, pebble lithology of the till corroborates other lines of evi-

dence suggesting initial glacial advance to the south. During ad-

vance till was lodged on northwest-facing hillslopes, and

bedrock clasts were dispersed to the south. As the margin of the

ice sheet thinned during deglaciation, topography exerted more

control, and ice flow shifted to a southwesterly direction. This later

direction is recorded by the northwest-southeast trend of recessional

ice-margin positions (described below) constructed from lake-level

histories and from the location of ice-contact slopes and ice-

marginal meltwater channels. Similar changes in ice flow in the

Pequest and Paulins Kill valleys southwest of the Hamburg quadran-

The Hamburg quadrangle is located within the north-draining

draining valleys of Papakating Creek, Beaver Run, and the Wallkill

River were dammed by the retreating ice front and a series of pro-

glacial lakes formed. These drained southward into the Paulins Kill

water from lakes in the Beaver Run and upper Wallkill valleys

drained southward, then westward, across bedrock interfluves and

drift dams. Eventually these lakes were succeeded by a single large

lake (glacial Lake Wallkill) which drained into the Paulins Kill basin

across the low point on the Paulins Kill-Wallkill divide, 8 miles

southwest of Sussex at an elevation of 500 feet (elevation determined

The southernmost ice-margin position in the Hamburg quadrangle

termed the Augusta Moraine by Connally and Sirkin (1973), is

marked by the North Church delta (units Qnc1, Qnc2), by a discon-

tinuous moraine trending eastward from Hardistonville across Ham-

burg Mountain by way of Mud Pond (unit Qnmp), and by small

glaciolacustrine deposits (units Qh1, Qh2) east of Hardistonville

(figure 2). The North Church delta was deposited in glacial Lake

North Church (Salisbury, 1902). This lake filled the upper Wallkill

valley and drained southward into the Paulins Kill basin across the

Germany Flats outwash surface near White Lake in the Newton

East quadrangle, 6 miles southwest of Hamburg. Kettle lakes at this

location indicate that stagnant ice was present, and as it melted the

spillway lowered. Three successively lower erosional channels cut

into the Germany Flats surface indicate that spillway elevations fell

from approximately 620 to 600 feet (Witte, 1988). The North

Church delta is a composite delta reflecting the lowering spillway

elevation. The broad, southernmost part of the delta (unit Qnc1d) is

separated from segments of a lower, more northerly delta on its east

and west sides (unit Qnc2d) by a distinct 15- to 20-foot scarp. Unit

Qnc1d is graded to an earlier, higher outlet of glacial Lake North

Church; unit Qnc2d was deposited from a more northerly ice front

and is graded to a later, lower outlet. Lacustrine fans north of

the North Church delta rise to elevations greater than 600 feet in

600 feet. These deposits were probably also laid down in the

lower stage of glacial Lake North Church, and they are included

with unit Qnc2. A glaciolacustrine unit in a small north-

sloping valley south of Rudeville (unit Qr1) was also deposited at

As ice retreated from the Augusta position glacial Lake Beaver Run

occupied the valley of Beaver Run. This lake was held in on the

south by a previously-deposited delta 3 miles northeast of Lafayette

in the Branchville quadrangle (Witte, in press), and drained south

across this delta at an elevation of 575 feet to the Paulins Kill

valley. The elevation of the topset-foreset contact (determined by

altimeter) in the small delta at Beaver Run confirms the 575-foot

outlet elevation. Unit Qbr includes this delta and adjacent

In the upper Wallkill valley glacial Lake North Church lowered

to an elevation of 590 feet when a low divide on bedrock was uncov-

ered by the retreating ice front just north of the North Church delta.

This uncovering permitted westward drainage into glacial Lake

Beaver Run in the Beaver Run valley. Two linear strings of lacus-

trine fans (unit Qnc3), one west of Hamburg and one trending along

the valley northeast of Hamburg, were deposited in this lake.

Although there are no exposures of topset-foreset contacts marking

the 590-foot level, several of these lacustrine fans, containing

Retreat of the ice front near Beaver Run exposed a divide on bed-

rock at an elevation of 550 feet half a mile north of Harmonyvale (in

the Branchville quadrangle), lowering glacial Lake Beaver Run to 550

feet (Witte, in press). The new, lower lake controlled by the 550-foot

spillway is here named glacial Lake Hamburg. At this time all drain-

age from the Wallkill basin was channeled through the outlet at

In the upper Wallkill valley the lowest stage of glacial Lake North

Church lowered to become conterminous with glacial Lake Hamburg

1.5 miles west of Hamburg was uncovered. At this time Pochuck

Mountain began to separate the ice into two sublobes: one occupying

Vernon Valley on the east and the other occupying the Wallkill

valley on the west. The relative positions of these lobes at the time of

lowering of glacial Lake North Church are indicated by the eleva-

tions of lacustrine gravels deposited by the Vernon Valley lobe in

only foreset bedding rise to an elevation of 580 feet, indicating

deposition in the lowest stage of Lake North Church. A delta having a

topset-foreset contact at 550 feet (determined by altimeter) lies a

quarter of a mile northeast of the fans, showing uncovering of the

aforementioned gap by the Wallkill sublobe and lowering of Lake

North Church to the Lake Hamburg level during retreat of the

Deposits in glacial Lake Hamburg (unit Qhm) include the delta

northeast of Hamburg just mentioned, a discontinuous area of sand

and gravel on the east side of the Wallkill valley north of Ham-

burg, generally less than 520 feet in elevation, and a linear string of

lacustrine fans, also generally below 520 feet in elevation, trending

northward along the west side of the Wallkill valley from Ham-

burg to Martins. Paleocurrent indicators in these last deposits were

tion at 16 sites. They generally show flow to the south, suggest-

ing that the deposits mark successive positions of the mouth of an

englacial or subglacial channel. Just to the south of Martins the

deposit broadens and rises to elevations above 580 feet where it

overlies a bedrock ridge. The gravelly deposits here are above lake

Further retreat of the ice front past the end of the Beaver Run-

Papakating Creek divide southeast of Sussex permitted glacial Lake

Hamburg to lower to the level of glacial Lake Wallkill. This lake

received the remainder of glacial deposition in the Hamburg

quadrangle. Deposits in this lake include deltas and lacustrine

After lowering of glacial Lake Hamburg, an ice block, or the Lake

Hamburg delta northeast of Hamburg, maintained a short-lived lake

at an elevation of 540 feet in the southern end of Vernon Valley.

cated by a well-developed outlet channel leading from a low col

in a bedrock ridge, cutting through the Lake Hamburg delta, and

terminating at a small delta at the glacial Lake Wallkill level.

Gravel terraces (unit Qma) banked on the sides of Vernon Valley

north from the outlet to the vicinity of Sand Hills may have been

deposited in Lake McAfee and in small ice-walled impoundments

along the valley wall at slightly higher elevations. By the time the

ice margin was at Sand Hills, however, the dam had melted or

Concurrently with glacial Lake McAfee in Vernon Valley, a small

north-draining valley north of Rudeville was dammed by ice and filled with two deltaic deposits (units Qr2, Qr3). A small north-

draining valley on Pochuck Mountain was similarly blocked

(unit Qsl). At the same time meltwater deposited thin outwash

The northernmost major ice margin position in the quadrangle,

termed the Sussex Moraine by Connally and Sirkin (1973), is

marked by a large delta northeast of Sussex in the Wallkill valley

glacial Lake Wallkill (figure 2). Lobation around Pochuck Moun-

tain linking the two deltas is indicated by well-developed ice-later-

Clove Brook valley graded to glacial Lake Wallkill and to the Liber-

tyville moraine and the prominent head-of-outwash east of Liberty-

Deposits north of the Sussex delta in glacial Lake Wallkill include a

linear string of lacustrine fans trending north from the delta, prob-

ably identical in origin to the deposit extending north from the North

Church delta; and fluvial-deltaic sand and gravel deposited at the

mouths of meltwater streams entering the lake from the west.

These latter deposits occur along Clove Brook, Quarryville Brook,

and in the unnamed valley east of Clove Brook. As ice retreated

northward out of the quadrangle deposition continued in glacial

Lake Wallkill, supplied principally by nonglacial drainage.

ville in the Branchville quadrangle (Witte, in press).

al meltwater channels on both sides of the mountain. This ice

margin is traceable westward to the prominent deltaic terraces in

and by a delta at Sand Hills in Vernon Valley, both deposited in

(unit Qpv) in the valley west of McAfee.

eroded and the lake level had dropped to join glacial Lake Wallkill.

The existence of this lake, here named glacial Lake McAfee, is indi-

level and may be subaerial ice-contact and fluvial sediment.

determined from foreset orientations, cross-beds, and gravel imbrica-

when a gap in the Beaver Run-upper Wallkill divide approximately

Augusta and into the Paulins Kill valley.

Vernon Valley sublobe over that distance.

only foreset beds, reach but do not exceed elevations of 580 feet.

places, and gravel terraces to the east near Rudeville also rise above

in the Delaware River basin. Deltas and lacustrine fans deposited

Wallkill basin. During late Wisconsinan deglaciation, the north-

gle were described by Ridge (1983) and Witte (1988).

low as 1 percent, possibly indicating little erosion of the local bed-

This change is possibly due to increasing distance from the outcrop

in the Leithsville Formation on the southeast side of the valley.

ward (all elevations determined by altimeter). Till on Pochuck Mountain contains from 52 to 78 percent gneiss clasts and from 27 to 42 percent sandstone and shale clasts. Carebble lithologies in stratified sediment were determined at 104 locabonate occurs only in trace amounts. These data again indicate tions (table 2). Generally the stratified deposits exhibit a greater predominantly local and southerly-transported clasts. An exception percentage of clasts derived from local bedrock than does till, to this pattern is a clayey silt till occupying the valley north of nowever, in many places pebble lithologies vary greatly over short Glenwood Lake. This till contains 80 to 90 percent sandstone and distances. This variation indicates that sediment was delivered to shale clasts, and approximately 5 percent carbonate and gneiss. the ice front from both subaerial meltwater streams along the ice Because no shale or sandstone bedrock crops out within 4 to 5 miles nargin and from local subglacial sources. of the valley (Hague and others, 1956; Offield, 1967; Canace, unpub.), the shale and sandstone clasts are probably derived from the stratified sediment of the shale terrain, shale and sandstone

> pebbles range from 91 to 99 percent of the total. Carbonate and gneiss pebbles are absent or scarce; quartzite accounts for 1 to 7 percent. In the Qwk unit atop the belt of carbonate bedrock in the Wallkill valley north of the Sussex delta, carbonate pebble content s sharply higher, ranging from 31 to 67 percent (Table 2, sites 30 to). Similarly, in the Sussex delta, carbonate pebbles are nearly absent west of the Wallkill River (sites 14, 15, 21-24) but comprise 18 to 39 percent of all pebbles just east of the river atop the carbonate bedrock belt (sites 25-27). This marked lack of lithologic mixing suggests sediment was derived from local subglacial sources, rather than from distant materials carried in upper parts of the glacier. A quarter of a mile farther east, in the part of the delta adjacent to Pochuck Mountain (sites 28, 29), carbonate percentage is nearly zero and the gneiss content is approximately 50 percent, indicating that sediment in this part of the delta was deposited by ice-marginal meltwater eroding the till on Pochuck Mountain. The channels north of Independence Corner were eroded by this meltwa-

In the lacustrine fans along Route 23 shale and sandstone clasts range from 77 to 96 percent of the total for approximately half a mile south of the shale-carbonate bedrock contact near Martins (sites 103-112). Carbonate content rises south of this line to range from 49 to 73 percent (sites 113-121), a marked transition noted by Salisbury (1902). As at the Sussex delta, a local subglacial sediment source is indicated. The deposits along the base of Pochuck Mountain on the east side of the valley (unit Qhm), are, on the other hand, rich in gneiss pebbles (71-85 percent, sites 97-99), indicating supply from ce-marginal channels on Pochuck Mountain.

Similar patterns prevail in Vernon Valley northeast of Hamburg. The deposits at the base of Pochuck Mountain (units Qhm and Qma) are rich in gneiss (51-86 percent, sites 51, 56, 64, 65, 75, 77); in the deposits on carbonate bedrock in the center of the valley (units Onc3, Ohm, Oma, and Owk) the carbonate percentage is higher (56-85 percent, sites 45, 50, 57, 59, 61, 63, 66-69, 71-74, 76, 78, 79, 82, 83). In the northern part of the valley, locally high sandstone and shale pebble content (42-80 percent, sites 44, 46-49, 51) may indicate subglacial erosion of the sandstone- and shale-rich till on the

Similar patterns mark the deposits in the carbonate bedrock terrain south of Hamburg. In the North Church delta (units Qncld, Onc2d) foreset and topset beds average 62 percent carbonate clasts (sites 124-126, 130-134), but ice-contact diamict on the north sides of the deposits show higher gneiss, shale, and sandstone content and an pattern suggests that the topset and foreset beds were deposited by subglacial meltwater eroding the local till and bedrock. Diamict on the ice-contact face formed from material slumping from the glacier surface and therefore reflects a more regional provenance. The stratified deposits east of the North Church delta (units Qh1, Qh2, Qnc1, Qnc2; sites 86, 87, 92-96) are primarily mixtures of carbonate (10-86 percent) and gneiss (7-58 percent) clasts. This mixture is similar to that in the till within the valley, which is continuous and thick in the area. The stratified sediment was probably derived from meltwater erosion of the till and underlying, with smaller contributions from bedrock eroded by ice-marginal meltwater descending along the west slope of Hamburg Mountain.

POSTGLACIAL HISTORY

When the Moodna Creek valley between Washingtonville and Cornwall, New York, 40 miles northeast of Sussex, was uncovered by the retreating ice front, water in the Wallkill basin drained eastward into the Hudson River basin. Three successively lower points on the Wallkill-Hudson divide between Goshen and Neelytown, New York were the spillways for the drainage. These spillways, which range in elevation from 440 feet above sea level at Goshen, to 370 feet at Lagrange, to 350 feet near Neelytown, probably operated in succession from highest to lowest as the ice front retreated northward. They succeeded the spillway on the Wallkill-Delaware divide at Augusta as the lowest point on the divide of the Wallkill basin, and the level of glacial Lake Wallkill lowered from an elevation of 500 feet to approximately 350 feet (Adams, 1934; Connally and Sirkin, 1967). In the Hamburg quadrangle, this event marked the beginning of extensive postglacial sedimentation, which continues at present.

The 350-foot lake did not extend into the Hamburg quadrangle. However, an earlier, shorter-lived stage controlled by the outlet at an elevation of 440 feet near Goshen, New York may have extended into the quadrangle as a very shallow lake in the Wallkill valley. Thin stream terrace deposits (unit Qst) overlying glacial lake bottom sediment along the Wallkill at an elevation of approximately 410 feet may have been deposited by nonglacial streams entering this lake. Draining of this lake to the 350-foot level, and then to much lower levels as the ice front continued to retreat through the Wallkill basin (Connally and Sirkin, 1967), exposed the lake bottom and initiated an estimated 10 to 15 feet of trenching (the approximate depth of oxidation in the lake-bottom sediments) by

As the ice sheet disappeared, isostatic rebound began to elevate the north end of the Wallkill basin relative to the south end. This upwarping lowered the gradient of the Wallkill and raised bedrock outcrops across its channel. The outcrops prevented further downcutting by the river. Marshes and shallow lakes formed upstream from these outcrops, and gradually became filled with silt and clay grading upward to peat and muck (unit Qs). This sequence overlies the trenched lake-bottom sediments and covers much of the Wallkill valley north of Route 23, and parts of the bottom of Vernon Valley and the lowland between Rudeville and Hardistonville. Swamp and marsh sediment also occurs in basins eroded in bedrock or dammed by till deposits on Hamburg Mountain and, to a lesser extent, on Pochuck Mountain and on the shale hills. The swamp and

the Wallkill River and its tributaries.

As marshes filled with peat, floodplain sediment, consisting chiefly of clay, silt, and minor sand (unit Qal), was deposited on the swamp deposits in places. Waksman and others (1943) report as much as 10 feet of silt and clay overlying peat along the Wallkill near Sussex. The alluvium thins with distance from the river and to the north, and is absent throughout much of the valley. Where marshes did not form during rebound, deposition of alluvium was continuous following the draining of glacial Lake Wallkill. The alluvium along Clove Brook, Papakating Creek, Beaver Run, the Wallkill River south of Route 23, and tributary streams in the shale hills is of this

commonly less than 15 feet thick (Waksman and others, 1943).

On uplands, downslope movement of newly-exposed till and bedrock immediately following deglaciation began to form aprons of colluvium along the bases of the steepest slopes (these deposits are included with unit Qt). In places where steep-gradient streams abruptly debouched onto lowlands, small alluvial fans were deposited (unit Qaf). Alluviation and, to a lesser extent, colluviation and swamp sedimentation, continue today, although the alluvial fans are generally relict.

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ollowing deglaciation, rebound of the earth's crust, which had been depressed by the weight of the ice sheet, elevated the earth's surface northward. The elevation of topset-foreset contacts in deltas deposited n glacial lakes mark the former planar water level of the glacial lake. the present elevation of these contacts can therefore be used to measure the relative rebound. In the Hamburg quadrangle, the topset-foreset contact in the Sussex delta occurs at an elevation of

approximately 520 feet, and in the Sand Hills delta at approximately 510 feet, yielding an average isostatic uplift of approxmately 3 feet per mile from the 500-foot outlet at Augusta northareas not mapped.

> from quarries. As much as 40 feet thick. Qal | ALLUVIUM: Silt and clay, minor sand and pebble-to-cobble gravel, gray to brown, well-sorted, thinly-stratified to massive. Contains variable amounts of organic matter. As much as 15 feet thick. In the Wallkill valley north of the junction of Papakating Creek alluvium overlies peat near the river (Waksman and others, 1943), where it forms small levees generally less than 4 feet high and 100 feet wide. Here, the alluvium is not mapped separately from unit Qs.

SWAMP DEPOSITS: Silt, clay, and minor sand; well-sorted and massive, overlain by peat, in turn overlain by muck and organic silt. Black, gray, and dark brown. Along major streams, map unit may include alluvium. Generally less than 15 feet thick but may be as much as 30 feet thick (Waksman and others, 1943).

Qaf | ALLUVIAL FAN DEPOSITS: Boulder, cobble, and pebble gravel, sand, and minor silt; brown to yellowish brown, poorly- to moderately-sorted, stratified. Forms fans where stream gradients change abruptly. As much as 20 feet thick Ost | STREAM TERRACE DEPOSITS: Pebble gravel, cobble

20 feet above present-day floodplain. Generally less than 15 TALUS: Angular boulders and cobbles of gneiss with little or no matrix material; gray, poorly-sorted, nonstratified. Forms an apron at the base of a cliff on Hamburg Mountain.

gravel, pebbly sand and silt; brown to yellowish brown,

well- to moderately-sorted, stratified. Forms terraces 10 to

As much as 20 feet thick (estimated). Many small talus

GLACIAL DEPOSITS (late Wisconsinan)

deposits are not mapped.

Lake-bottom Deposits--Well-sorted, thinly-stratified, gray (where unoxidized) to brown and yellowish brown (where oxidized) silt, clay, and fine sand, deposited on the bottom of glacial lakes. In Vernon Valley the deposits are as much as 170 feet thick; in the Wallkill valley they are as much as 100 feet thick. In the Papakating valley the deposits are generally less than 40 feet thick.

Ql Silt, clay, and fine sand. Uncorrelated to specific lakes. Qwkl | Silt, clay, and fine sand deposited in glacial Lake Wallkill. Qmal | Silt, clay, and fine sand deposited in glacial Lake McAfee.

clay, and fine sand deposited in glacial Lake Beaver Qnc31 | Silt, clay, and fine sand deposited in lowest stage of glacial

Qnc21 | Silt, clay, and fine sand deposited in lower stage of glacial Lake North Church.

Qnc11 Silt, clay, and fine sand deposited in high stage of glacial Lake North Church.

Qncl Silt, clay, and fine sand deposited in glacial Lake North

Church, uncorrelated to specific stage.

Sand and Gravel Deposits in Major Glacial Lakes--Well-sorted; stratified; brown, yellow, and gray; sand, pebbly sand, pebble gravel, cobble gravel, and minor boulder gravel. Deposited in deltas (indicated by suffix "d") and lacustrine fans in major glacial lakes. Includes scattered beds of poorly-sorted, nonstratified gravelly sand diamict sediment. Deltas consist of horizontal topset beds of pebble and cobble gravel and sand generally less than 20 feet thick deposited above lake level overlying dipping foreset beds of pebbly sand and sand as much as 100 feet thick deposited below lake level. This sequence rests on bedrock and till in places; elsewhere it is underlain by lake-bottom sediment and by lacustrine-fan sand and gravel deposited along the retreating ice front prior to delta progradation. Lacustrine fans consist of dipping foreset beds of sand and pebble gravel and, locally, cobble-to-boulder gravel and minor diamict, all deposited below lake level. These deposits may be as much as 200 feet thick. They generally rest on bedrock and till,

Brook; and a non-ice-contact delta northeast of Hamburg Branchville quadrangle.

Oma | Sand and gravel deposited in glacial Lake McAfee. Includes collapsed deltaic cobble- and pebble-gravel terraces along the the valley. Map unit includes lacustrine and fluvial sedi-

a mile north of Harmonyvale in the Branchville quadrangle.

Rudeville and McAfee.

north-draining valley south of McAfee. Spillway to south at an elevation of approximately 630 feet. Maximum thickness 80 feet (estimated).

Qr1 | Cobble gravel and sand filling small north-draining valley just south of Rudeville. Spillway to south at an elevation of

thickness 40 feet. Glaciofluvial Deposits--Moderately- to well-sorted; stratified; brown, yellow, and gray; pebble-to-cobble gravel and

Qpv PLEASANT VALLEY OUTWASH--Cobble and pebble gravel and sand forming terraces graded to channel through the Lake Hamburg delta to the south. Probably fluvial. Maximum thickness 20 feet (estimated).

DESCRIPTION OF MAP UNITS

POSTGLACIAL DEPOSITS (Holocene and late Wisconsinan) af ARTIFICIAL FILL: Artificially emplaced till, sand, gravel and bedrock; construction debris (brick, concrete, asphalt); cinders and slag; in railroad and highway embankments, dams, and filled land. As much as 20 feet thick; generally less than 10 feet thick. Small areas of fill in urban

OUARRY TAILINGS: Embankments of rock excavated

Qkmu UNCORRELATED MORAINIC DEPOSIT--Kittatinny till

Contact--Dashed where approximately located, short-dashed

areas shown as a solid pattern generally consist of a thin Qhml | Silt, clay, and fine sand deposited in glacial Lake Hamburg. rubble of angular shale chips with little or no undisturbed

> drainageway, bounded in places by cutbanks, in which present stream is underfit or absent. Dashed where poorly

ice. Long axis of hill parallels direction of ice flow. Open

Arrow shows inferred direction of glacier flow. Observation **Drumlin**--Rounded, elliptical hill shaped by moving glacial

indicates that hill is composed of a core of weathered gneiss Spillway for glacial lake--Lettering indicates associated

►pwt Pre-late Wisconsinan till observed in excavation

Active gravel pit (1985)

★ Inactive gravel pit (1985)

Active quarry (1985)

Inactive quarry (1985)

Surface Texture of Stratified Deposits

Well or test boring on cross sections

47△ Site of clast lithology count--Data in table 2.

0 1 2 miles

Figure 1.--Simplified bedrock lithologies of the Hamburg quadrangle.

Streams shown by dashed lines. Carbonate rocks include dolomite,

CORRELATION OF MAP UNITS

marble, and limestone.

Qbr Qbrl Qnc3 Qnc31

VERTICAL EXAGGERATION X

cobble gravel and sand

pebble gravel and sand

470 Well with log in table 1

pebbly sand

fine sand and silt

but in places they may be underlain by lake-bottom sediment. Qwk | Sand and gravel deposited in, or graded to, glacial Lake Qwkd | Wallkill. Includes lacustrine fans in the Wallkill valley from Sussex northward; ice-contact deltas at Sussex, Sand Hills, and Quarryville Brook; fluvial-deltaic terraces along Clove

sides of Vernon Valley, and lacustrine fans in the center of ments deposited in small ice-walled impoundments on the

Qhm | Sand and gravel deposited in glacial Lake Hamburg. Includes Qhmd the lacustrine fans along Route 23 and along the southwest side of Pochuck Mountain, and an ice-contact delta northeast of Hamburg. Spillway at 550 feet above sea level about half

cludes an ice-contact delta at Beaver Run and adjacent lacustrine fans. Spillway at 575 feet above sea level about one mile south of Harmonyvale in the Branchville quadrangle. 2nc3 | Sand and gravel deposited in the lowest stage of glacial Lake North Church. Includes lacustrine fans in and northeast of Hamburg, and a string of lacustrine fans trending northward

White Lake in the Newton East quadrangle. Onc1 | Sand and gravel deposited in the earliest, highest stage of Qnc1d | glacial Lake North Church. Includes the large, central part of the North Church delta, a small non-ice-contact delta in Franklin deposited by ice-marginal meltwater, and lacustrine fan deposits along the Wallkill River. Spillway at about 630

Deposits in Small Glacial Lakes--Moderately- to wellsorted; stratified; brown, yellow, and gray; sand and pebbleto-cobble gravel, minor silt and clay. Deposited in small proglacial lakes in north-sloping valleys dammed by ice. These deposits are chiefly deltaic; minor fluvial, lacustrinefan, and lake-bottom deposits also occur.

HARDISTONVILLE DEPOSITS--Deltaic sediments (Qh2 and Qh1) laid down in two small valleys east of Hardiston-

Hardistonville. Spillway to south at an elevation of about 670 feet. Maximum thickness 20 feet (estimated). Qh1 Pebble-to-cobble gravel and sand partially filling small northsloping valleys east of Hardistonville. Spillway to south at an elevation of approximately 650 feet. Maximum thickness 80

Qr2 | Cobble gravel and sand forming a terrace along base of Hamburg Mountain. Possibly an ice-walled fluvial deposit graded to outlet for Qr3. Maximum thickness 20 feet (esti-

sand. Deposited by streams of glacial meltwater in valleys not occupied by glacial lakes.

Qpq PEQUANNOCK OUTWASH--Cobble and pebble gravel and

Till and Related Deposits--Poorly-sorted, nonstratified sediment comprised of varying amounts of boulders, pebbles, and cobbles in a matrix ranging from clayey silt to silty sand. Deposited directly by glacial ice or by flow of sediment from glacial ice. Occurs in drumlins, as a layer of variable thickness overlying bedrock, and in moraines. Map units Qn and Qk include small deposits of colluvium at the base of steep slopes. These deposits are formed by downslope movement of till and underlying bedrock and may be as much as 10 feet KITTATINNY TILL--Light brownish gray to very pale

brown clayey silt to sandy silt with some to many subrounded to subangular pebbles and cobbles and few to some subrounded boulders. Gravel includes mostly gray carbonate rock or gray mudstone, shale, and sandstone; subordinate rock types include white to gray quartzite and quartzite conglomerate, and gneiss, which becomes more abundant near contact with unit Qn. Boulders are generally quartzite, sandstone, and carbonate rock. In areas of continuous till, well logs (table 1) indicate that unit Qk may be as much as 70 feet thick. In the drumlins in the northern part of Vernon Valley it may be as much as 120 feet thick.

NETCONG TILL--Very pale brown to yellowish brown sandy silt to silty sand with many subrounded to subangular pebbles and cobbles and some to many subrounded boulders. Gravel includes chiefly gneiss and gray mudstone, shale, and sandstone, with lesser amounts of gray carbonate and white to gray quartzite and quartzite-conglomerate. Boulders are chiefly gneiss with few to some carbonate, sandstone, and quartzite. In areas of continuous till on Pochuck Mountain well logs (table 1) indicate that unit Qn may be as much as 165 feet thick, and in places is underlain by weathered gneiss as much as 180 feet thick. Much of the sediment in the till in these areas may be derived from the weathered gneiss. In the drumlins east of Hamburg, well logs indicate till as thick as 160 feet, although much of this thickness may be till of prelate Wisconsinan age (refer to text).

Onmp | MUD POND MORAINE--Netcong till forming a discontinuous linear belt of gentle hummocky topography extending from southeast of Hardistonville eastward across Hamburg Mountain. The moraine includes a low ice-marginal ridge on the south shore of Mud Pond. Maximum thickness of till in the moraine is estimated to be 40 feet.

forming a small area of gentle hummocky topography on Pochuck Mountain. Maximum thickness of till is estimated to be 20 feet. Correlation to major recessional ice margin positions uncertain.

MAP SYMBOLS

where feathering or gradational, dotted where excavated or inferred beneath fill. Bedrock Outcrop--Ruled pattern indicates scattered bedrock outcrop; surficial deposits generally less than 10 feet thick. Solid pattern indicates extensive bedrock out-•-wr crop; surficial deposits generally absent. Notation "wr" indicates outcrop of weathered bedrock. On shale bedrock,

Meltwater channel--Narrow, linear, boulder-filled

Striation--Linear glacial abrasion mark on bedrock surface.

symbol indicates that hill is composed of till; line in symbol

Stream-cut or meltwater-cut scarp--Line at top of scarp,

Asymmetric ridge of till--Line at crest, barbs on gentle

Artificial excavation scarp--Line at top of scarp, ticks on

— 300 — Elevation of bedrock surface--In feet above sea level,

contour interval 100 feet. Shown only in major buried val-

Base map from U. S. Geological Survey, 1954

VERTICAL EXAGGERATION X5

¹New Jersey Geological Survey

²United States Geological Survey

slope. May have been formed by push of active ice.

deposited by water draining from glacial Lake McAfee. Spillway at 500 feet above sea level near Augusta in the

valley walls at higher elevations. Spillway at 540 feet above sea level across bedrock ridge about one mile southwest of

Qbr | Sand and gravel deposited in glacial Lake Beaver Run. Inmarsh sediment may attain thicknesses of 30 feet but is more

> from the North Church delta. Spillway at 590 feet above sea level about half a mile north of North Church. Qnc2 | Sand and gravel deposited in the lower stage of glacial Lake Qnc2d North Church. Includes the lower east and west sides of the North Church delta, lacustrine fans north of the North Church delta, and small fluvial and deltaic deposits near Rudeville. Spillway at about 610 feet above sea level near

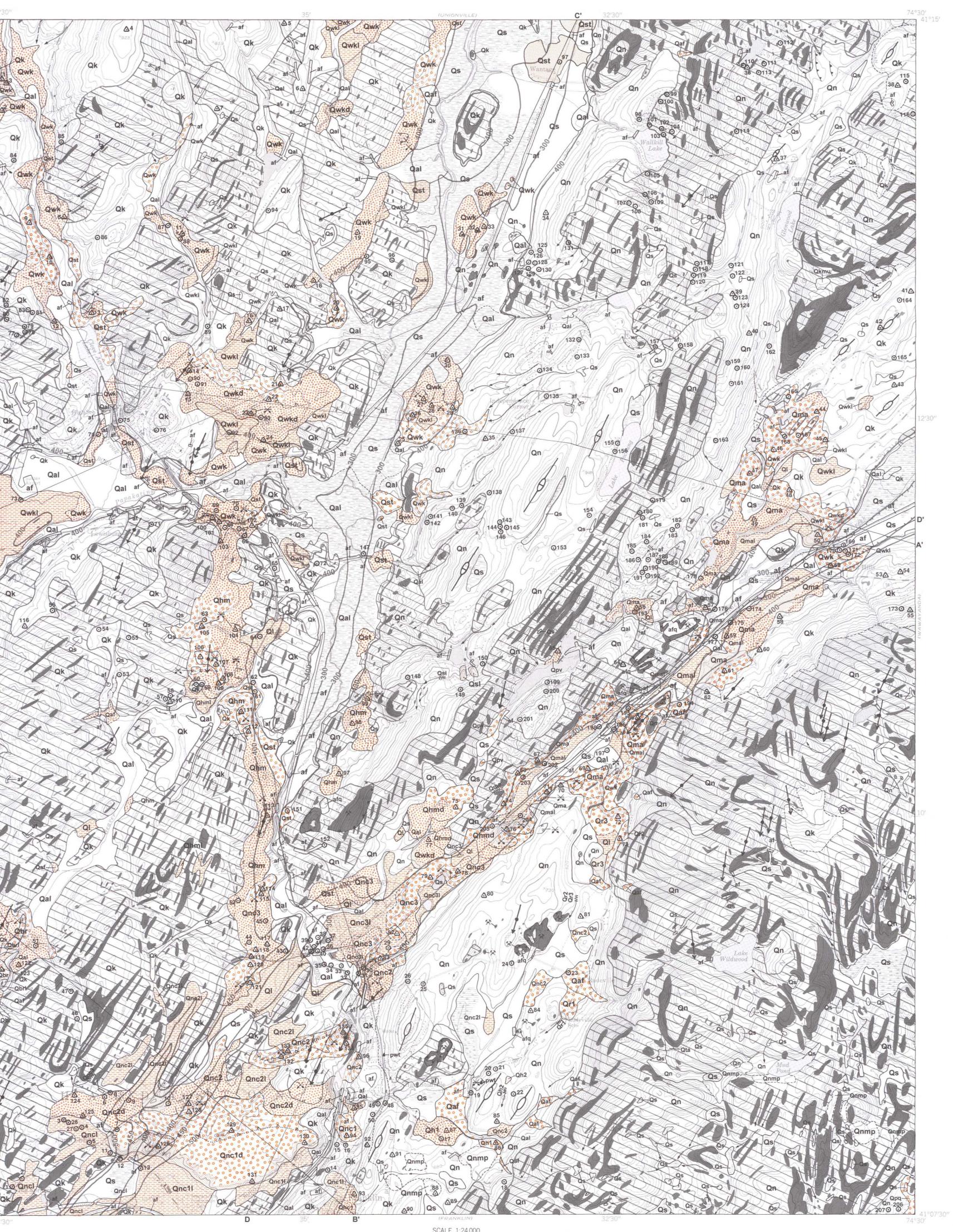
feet above sea level near White Lake in the Newton East

Qh2 Pebbly sand in north-sloping valley between drumlins east of

RUDEVILLE DEPOSITS--Deltaic and fluvial sediments (Qr3, Qr2, Qr1) laid down in two small valleys between Qr3 Cobble gravel and sand grading south to pebbly sand filling

approximately 680 feet. Maximum thickness 40 feet (estimat-Osl | SCENIC LAKES DEPOSIT--Pebbly sand forming two knolls in small north-draining valley on Pochuck Mountain. Spillway to west at an elevation of about 720 feet. Maximum

sand. Maximum thickness 15 feet (estimated).



SURFICIAL GEOLOGIC MAP OF THE HAMBURG QUADRANGLE

SUSSEX COUNTY, NEW JERSEY

HHHHH

CONTOUR INTERVAL 20 FEET

DATUM IS MEAN SEA LEVEL

Scott D. Stanford¹, David P. Harper¹, and Byron D. Stone

Bedrock

5-10 olive brown silty fine sand with 107 22-19127 0-5 clay (Qn) 10-25 gray silty clay with cobbles (Qnc31) 40 on file at no log, 72 feet to rock 109 22-19236 0-12 clay and gravel (Qn) screened in sand from 53-73, yield 230 gpm no log, 56 feet to bedrock (this thickness may include some weathered bedrock) 110 22-3810 41 22-21979 0-150 sand and gravel (Qnc3l over Qnc3) 150-162 decomposed limestone 111 22-5974 no log, 11 feet to bedrock 112 22-18593 no log, 3 feet to bedrock Figure 2.--Shorelines of glacial lakes, recessional ice margins and deposits, striations, drumlins, glacial lake spillways, and places named in text for the Hamburg quadrangle. Glacial lakeshore abbreviations are: NC1,2=Lake North Church, high stages; NC3=Lake North Church, lowest stage; HM=Lake Hamburg; BR=Lake Beaver Run; MA=Lake McAfee; WK=Lake Wallkill

spillway of glacial lake

striation

Table 1.--Selected Well Records

22-1738

10 22-1419

12 22-18501

14 on file at

15 on file at

17 22-1765

25 22-121

29 22-13545

31 22-5626

33 on file at

35 on file at

on file at the N. J.

38 22-20150 0-7

39 22-20148 0-5

Geology mapped 1983-85, 1994-95

Reviewed by R. W. Witte, R. F. Dalton, I. G. Grossman, R. Canace

QUADRANGLE LOCATION

22-19841 no log, 3 feet to bedrock

22-19126 0-6 clay overburden (Qncl)

6 22-21996 0-80 sand and gravel (Qnc2d)

8 22-6572 no log, >212 feet to bedrock

9 22-11565 no log, >138 feet to bedrock

11 22-6979 no log, 30 feet to bedrock

13 22-21037 0-73 sand and gravel (thin Qnc11 over

16 22-19630 0-55 clay and gravel (Qk)

18 22-22862 0-10 overburden (Qn)

24 22-20137 no log, 88 feet to rock

26 22-20672 no log, 163 feet to rock

30 on file at no log, 90 feet to bedrock

32 on file at no log, 60 feet to bedrock

34 on file at no log, 20 feet to bedrock

no log, 75 feet to bedrock

no log, 30 feet to bedrock

0-60 stratified drift (Qnc31, possibly

brown medium fine sand, little

brown silt, trace clay, and fine

gray silty clay with cobbles (Qnc31

19 22-19185 0-132 sand, gravel, clay (Qn)

21 22-19112 0-40 clay and boulders (Qn)

bedrock not reached

22 22-19408 0-164 clay, boulders, sand, gravel (Qn)

23 22-22494 0-85 sand and gravel (Qaf over Qr1)

no log, 85 feet to rock

27 22-23217 0-12 clay overburden (Qncl)

28 22-21213 0-48 clay overburden (Qncl)

20 22-22483 0-50 clay and gravel (Qn)

13 feet to dense blue limestone

abbreviated log
0-80 light yellowish gray calcareous

105-110 sand and gravel (Qn or pre-advance

sand with some traces of clay (Onc.

105-113 gravel with trace clay (Qnc3 or Q screened 78-96, yield 942 gpm

dy silt and numerous pebbles

22-18493 0-22 sandy clay (Qncl)

Well Permit Driller's Log of Materials Overlying Bedrock²

22-22782 0-38 sand and gravel overburden (Qncl)

22-18426 0-40 clay and gravel overburden (Qncl)

screened 208-218, yield 10 gpm

sand, gravel (thin Qnc1l over Qnc1d)

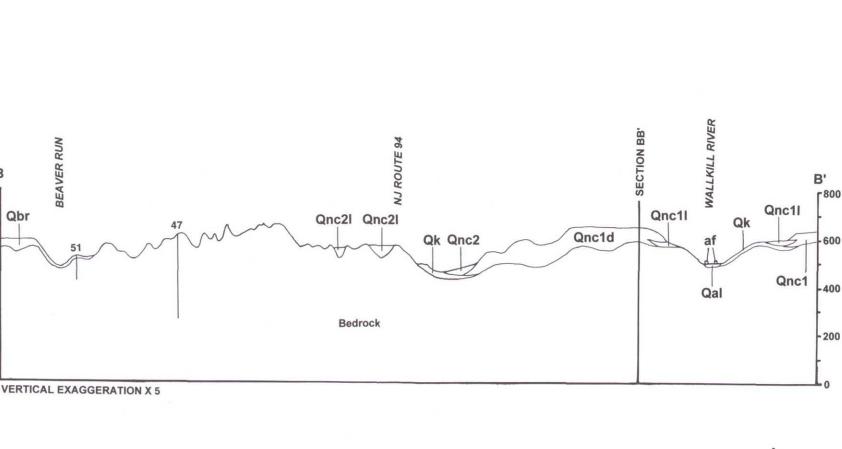
Depth Description

185 22-19432 189 22-19474 0-2 clay (Qn) 190 22-20990 191 22-20991 192 22-20588 0-25 clay overburden (Qn) 194 22-8612 0-116 sand and gravel (Qaf over Qma) 195 22-9430 0-154 clay, sand, conglomerate (Qma) 196 22-6147 bedrock not reached

recessional ice margin sand and gravel deposited in deltas and lacustrine fans

till deposited in moraines

gravel fill gray fine sand (Qal over Qmal) Geological 62-92 gray sand and pebble gravel (Qma)
Survey at 92 refusal



198 22-20147 0-120 sand and gravel (Qmal over Qma)

202 22-19647 0-112 sand and gravel (thin Qmal over

201 22-20702 no log, 80 feet to bedrock

0-80 clay and gravel (Qn) 80-233 rotten rock (weathered gneiss)

119 22-18348 0-9 clay and broken bedrock (Qn) 207 22-18006 0-31 hardpan, stones, lenses of sand and sued by New Jersey Department of Environmental Protection and Energy, Bureau of Water Allocation. erred map units and author's comments in parenthes lons per minute (gpm) are listed below the litholo

203 22-22451 0-130 sand and gravel (Qma)

204 22-6740 0-100 fine sand and silt (Qma 100-115 coarse sand (Qhmd)

205 22-20791 0-103 sand and gravel (Qhmd)

0-40 overburden with boulders (Qn)

Table 2.--Lithology of clasts in surficial units Site Unit Number of Percentages of Clasts Dolomite Gneiss Shale Quartzite

0-70 overburden (thin Qwk over Qn) 300-325 rotten granite (weathered gneiss) 141 22-20555 0-153 clay and gravel overburden (Qn) 142 22-20207 0-130 clay, sand, gravel overburden (Qn) 15 Qwkd 101 dark yellowish brown fine sand and silt with pebbles and cobbles (Qal) n cooperation 9-13 dark yellowish brown clayey silt Geological 13-75 gray laminated silt and clay, mino very fine sand (unoxidized Qwkl at 76 refusal grav overburden with gravel (On) 151 22-19580 0-30 sand and gravel overburden (Qst)

54 22-18698 0-100 sand, clay, hardpan overbu 100-170 rotten rock (weathered rock 155 22-21927 0-29 clay and gravel (Qn) 157 22-20025 0-32 clay and gravel (Qn) 159 22-9247 0-10 clay, gravel, hardpan conglomerate 160 22-20178 0-40 clay and gravel (Qn) 162 22-18890 0-50 clay and gravel (Qn) 163 22-19468 0-65 sand and gravel (Qn) dirt and small boulders (O 40-90 gravel and clay (Qk) 90-106 clay (Qk or weathered carbonate 182-190 ledges of rock and soft fine sand 166 22-21959 0-40 clay and gravel (thin Qma over Qk) 167 22-6546 0-58 gravel and sand (Qma)

168 22-8657 0-136 conglomerate, sand, gravel, clay alcium carbonate in places very dark brown fine sand and silt with the U.S. 8-24 olive gray silt and very fine sand 24-35 gray laminated silt and very fine gray medium sand (Qwk) refusal on gravel 170 22-21038 0-170 sand and gravel overburden (thin 171 22-13297 0-155 sand and gravel overburden (thin 172 22-20240 0-144 sand and gravel (thin Qwkl over

173 22-19411 no log, 65 feet to bedrock soft top soil gray clay with streaks of silt clay and gravel (Qmal, Qma) silty clay with broken stone an swamp muck (Qs) fine sand (Qma) sand and gravel (Qma) reened 46-56, yield 250 gpm clay, sand, gravel (Qma) rock and fill gravel, sand, and clay (Qal) clay and gravel streaks (Qmal clay and fine sand (Qmal fine sand and clay (O 5-198 sand and gravel (Oma

0-22 gravel and sand (Oma) 109 Qhm 179 22-18520 no log, 14 feet to bedrock 110 Qn 114 180 22-21448 no log, 30 feet to bedrock 111 Qhm 143 30-70 sand, gravel, and clay (Qn) rotten limestone 182 22-20529 no log, 45 feet to bedrock 183 22-20330 no log, 20 feet to bedrock

114 Qnc3 184 22-19464 0-165 clay and gravel overburden (Qr 165-250 rotten rock (weathered gneiss) 0-112 sand and gravel 112-148 ledge (bedrock) 148-175 gravel (weathered gneiss) 186 22-19051 0-115 clay, sand, and gravel (Qn) 115-235 rotten rock (weathered gnei 187 22-20834 0-16 clay overburden (Qn) 126 Qnc1 1 188 22-20799 0-34 clay and gravel (Qn)

> b indicates boulders, c indicates cobbles, all other counts ²Consists of gray and brown shale and sandstone from the Martinsburg Formation. ³Includes minor amounts of red siltstone and sandstone from the High Falls or Hardyston Formations.