U.S. Department of the Interior
U.S. Geological Survey

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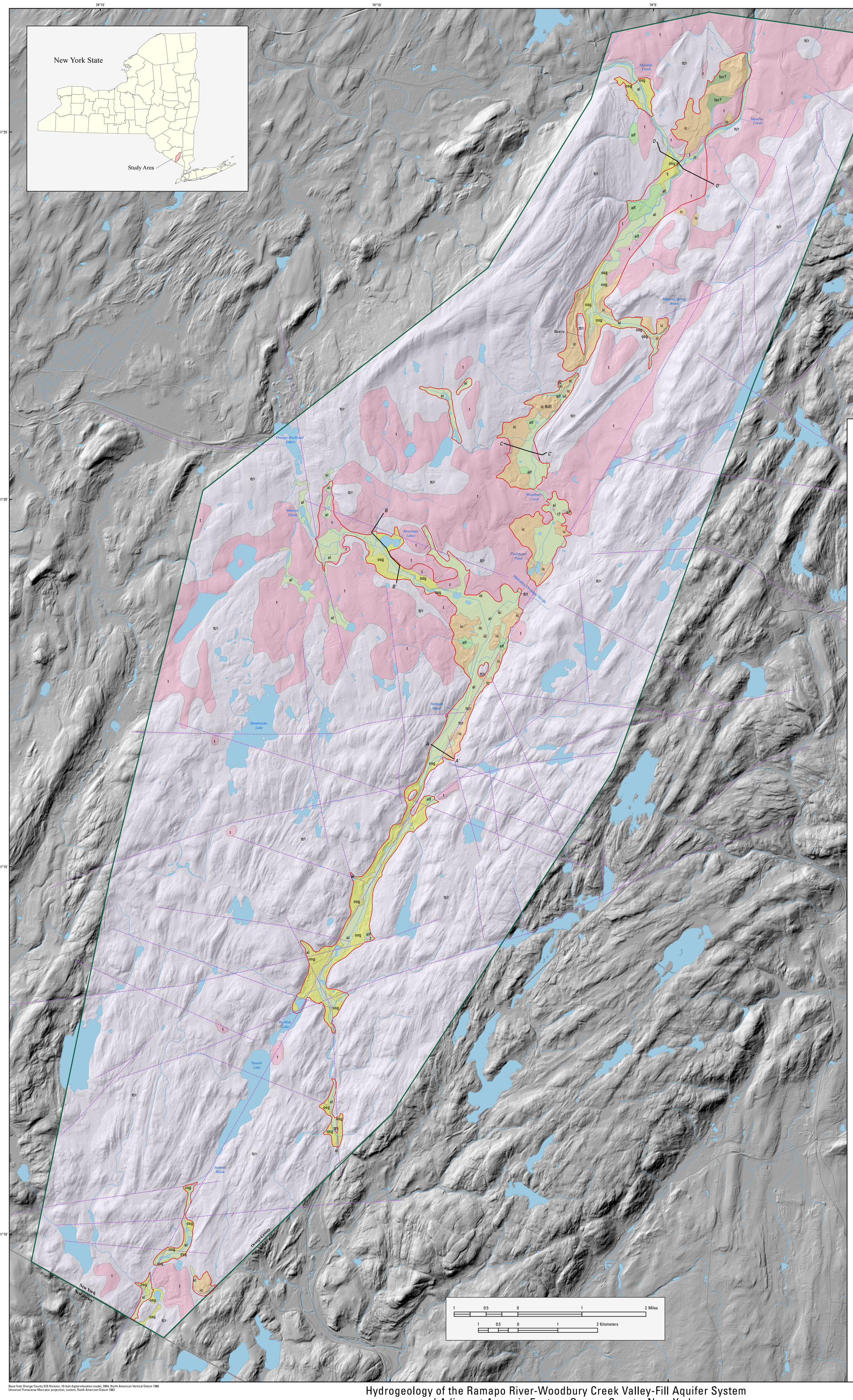
Scientific Investigations Report 2014-5156
Plate 1



EXPLANATION

SURFICIAL GEOLOGY
HOLOCENE

al — **Alluvium** – Postglacial river and stream flood plain deposits consisting predominantly of stratified silt and clean to silty sand, commonly with some gravel at the base of the deposit. Alluvium generally occurs within 10 feet (ft) of the present-day stream or river level. Thickness as much as 15 to 25 ft

alf — **Alluvial fan** – Fan-shaped accumulations of stratified silty sand and gravel, deposited by tributary streams where they enter the Ramapo River and Woodbury Creek valleys. Maximum thickness of fans may approach 40 ft, but is likely less than 20 ft for most fans Alluvial fan deposits have relatively high permeability, but are relatively thin and largely unsaturated. Fan deposits are an important conduit for groundwater recharge if the underlying glacial deposits are permeable. Most fans in the northern half of the study area overlie fine-grained deposits that limit recharge.

af — **Artificial fill** – Mapped area is limited to the landfill at Mountainville. Constructed landforms such as railroad and highway grades and land regrading in commercial areas were not mapped, but are evident on the light detection and ranging (lidar) imagery. The surficial deposit map layer indicates the underlying or original deposits beneath these areas as inferred from well logs, nearby deposits, and old topographic maps.

Water – Areas of open water such as lakes, large ponds, and reservoirs.

PLEISTOCENE

osg — **Outwash sand and gravel** – Stratified, well-sorted sand and gravel deposited by glacial meltwater streams away from the ice front as valley-train outwash (originally spanning the width of the valley). Outwash terraces or topset beds of deltas near the receding ice front also are included. Outwash in the Ramapo River Woodbury Creek valley is largely limited to the southward draining Ramapo River section. Outwash deposits are delineated within the short, west-to-east section of the Ramapo River and from Arden downvalley to the south. Upper surfaces generally 20 to 60 ft above river level, except at the head of the outwash near Arden, where the valley is constricted and incision approaches 70 ft.
Outwash sand and gravel deposits have very high permeability, but somewhat limited aquifer potential because of thin saturated thicknesses.

Ice-contact deposits (formerly referred to as kame deposits) – Stratified sand, gravel, and silt deposited by meltwater in a variety of environments in close proximity to glacial ice. Till may be intermixed with some deposits because of localized slumping or mass movement from melting ice. Highly variable sorting and chaotic bedding from melting ice is paralleled by highly variable permeability. Largely unsaturated along valley walls above the present-day flood plain.

ic — **Ice-contact sand and gravel** – Undifferentiated ice-contact deposits of poor- to well-sorted sand and gravel with variable silt that was deposited adjacent to, or beneath, within, or on top of melting glacial ice. Includes geomorphic features such as kames, kame terraces, kame deltas, eskers, and permeable hummocky terrain mostly within valleys. Coarse stratified deposits in the subsurface likely originated from subglacial drainage or subaqueous or lacustrine fans, deposited where meltwater discharged into proglacial lakes. Extreme variability in sorting, grain size, and thickness of individual beds. Moderate to high permeability, high permeability especially in coarse, well-sorted zones. Deposits situated at low elevation (below the valley floor) and with favorable characteristics (high permeability) form localized unconfined or confined aquifers.

ic (kd) — **Kame delta** – Ice-contact deposits of sorted sand and gravel that were deposited as prograding deltas into proglacial lakes or gaps in decaying ice within the valley. Delta deposits can include fine-grained bottomset beds (lacustrine sand and silt) over which foreset beds (sand and fine gravel) and topset beds (fluvial coarse sand and gravel) prograde. Generally well sorted; foreset and topset beds are suitable aquifer material, but deposits are generally above the present-day floodplain and thus may have limited saturated thickness.

lsc? — **Lacustrine fine sand, silt, clay** – Fine-grained stratified drift deposited in lakes. Question mark indicates uncertainty (alluvial?).

Subsurface extent of lacustrine sand and silt or silt and clay – Glaciolacustrine deposits of thinly to massively bedded silt, fine to very fine sand, and some clay. Deposited as lake-bottom sediments in proglacial lakes that formed as result of the temporary dams created by ice, till moraines, or downvalley ice-marginal deposits, such as high-outwash valley trains and kame moraine and kame delta deposits. Thickness can reach as much as 150 ft. These deposits have low permeability and form the principal confining unit in the Ramapo River – Woodbury Creek valley-fill aquifer system.

Till confining unit – Areas where till is known to at least locally confine sand and gravel.

t — **Thick till** –Thick (greater than or equal to 50 ft), unsorted, unstratified mixture of clay, silt, sand, gravel, and boulders deposited beneath the ice as lodgment till during a glacial advance or at the edge of the ice sheet by melting ice as ablation till during a pause, or retreat, of the ice front. Thicknesses up to 350 ft at the north end of the study area. Very low permeability, but may yield adequate amounts of water for domestic use to large-diameter dug wells where sufficiently saturated or where gravelly zones of higher permeability exist. Present mostly in lee (south) of Schunemunk Mountain (in and around the villages of Monroe, Harriman, and Kiryas Joel) and north of Woodbury to Mountainville. Forms the midvalley drainage divide in the Ramapo River – Woodbury Creek valley.

tt/r — **Thin till or exposed bedrock** – A thin, discontinuous veneer of till, 0 to 50 ft thick, over bedrock. Lidar imagery in plate 1 shows structural features of bedrock in areas with little or no till cover.

A — A′ **Trace of hydrogeologic section** – Hydrogeologic sections are included as separate illustrations within the report.

Aquifer boundary –Approximate areal extent of the stratified-drift aquifer system. The contact is generally between the stratified drift (all Pleistocene deposits described above except till, unless till is underlain by sand and gravel) in the valley areas and either valley walls of till or bedrock, or hills of bedrock and till within the valleys.

Esker – Symbol indicates the axis of esker landform. Eskers are the remnant ice-contact deposits formed within meltwater tunnels in or beneath stagnant ice.

5, 10, 50 — **Thickness of saturated sand and gravel** – In feet, from available well-log data; silt content is variable and may limit the resource. Dashed where inferred.

600, 500, 400, 300, 200, 100 — **Elevation of bedrock surface** – In feet above the North American Vertical Datum of 1988 – beneath glacial deposits within the Ramapo River – Woodbury Creek valley. Largely controlled by bedrock structure such as faults and lineaments, as well as differential erodability of bedrock types, consistent with topographic valley south of Harriman, but some departures north of Woodbury, where thick till deposits have shifted present-day drainage. All lines are dashed, to reflect uncertainty, especially in faulted valley areas, which may have locally deep weathered bedrock.

Streams – Rivers, creeks, and unnamed tributaries

Roads – Highways and primary roads

Lineaments – Linear features evident on lidar imagery that cut across bedrock fabric; some represent faults, but are not differentiated here. Primary features shown here are generally well-defined and cross or end at valleys. Secondary features (not shown) are generally shorter and do not intersect valleys. Locations where lineaments cross the Ramapo River – Woodbury Creek valley may have enhanced water-resource potential if they are permeable and convey upland water toward the valley.

Meltwater channels – Channel-form features identified primarily with Lidar imagery and, in some locales, with soil parent material. Such features may represent temporary drainage courses during deglaciation. Most are in upland or valley-wall areas in the lee of Schunemunk Mountain, dominated by till that has been eroded. Many features have no present-day drainage, and many that do have been altered by post-glacial drainage development and human activities. Smaller channels are floored in till or have several feet of stratified sediments over till. Larger channel reaches have alluvial soils (and may be underlain by lacustrine sediments which locally overlie sand and gravel, see well 01563). Sand and gravel and bedrock wells in such areas have modest yields (15-120 gal/min).

69 — **Horizontal-to-vertical passive seismic survey site** – Number is estimated depth to bedrock, in feet. NA indicates no analysis, most likely because till overlies bedrock at the site.

02046 — **Well** – Completed in glacial-drift deposits in the Ramapo River – Woodbury Creek valley or isolated stratified deposits at higher elevations. Label is well identification number assigned by the U. S. Geological Survey (USGS).

01754 — **Well** – Completed in bedrock. Label is well identification number assigned by the USGS.

0 428 — **Well** – Completion unknown. Deep upland wells most likely completed in bedrock. Label is well identification number assigned by the USGS.

01405 — **Test boring** – Test boring used to define unconsolidated sediments and, at some sites, depth to bedrock, for engineering construction properties; no casing installed. Label is well identification number assigned by the USGS.

Base from Orange County GIS Division, 10-foot digital elevation model, 2004, North American Vertical Datum 1988
Universal Transverse Mercator projection, custom, North American Datum 1983

Hydrogeology of the Ramapo River-Woodbury Creek Valley-Fill Aquifer System and Adjacent Areas in Eastern Orange County, New York

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