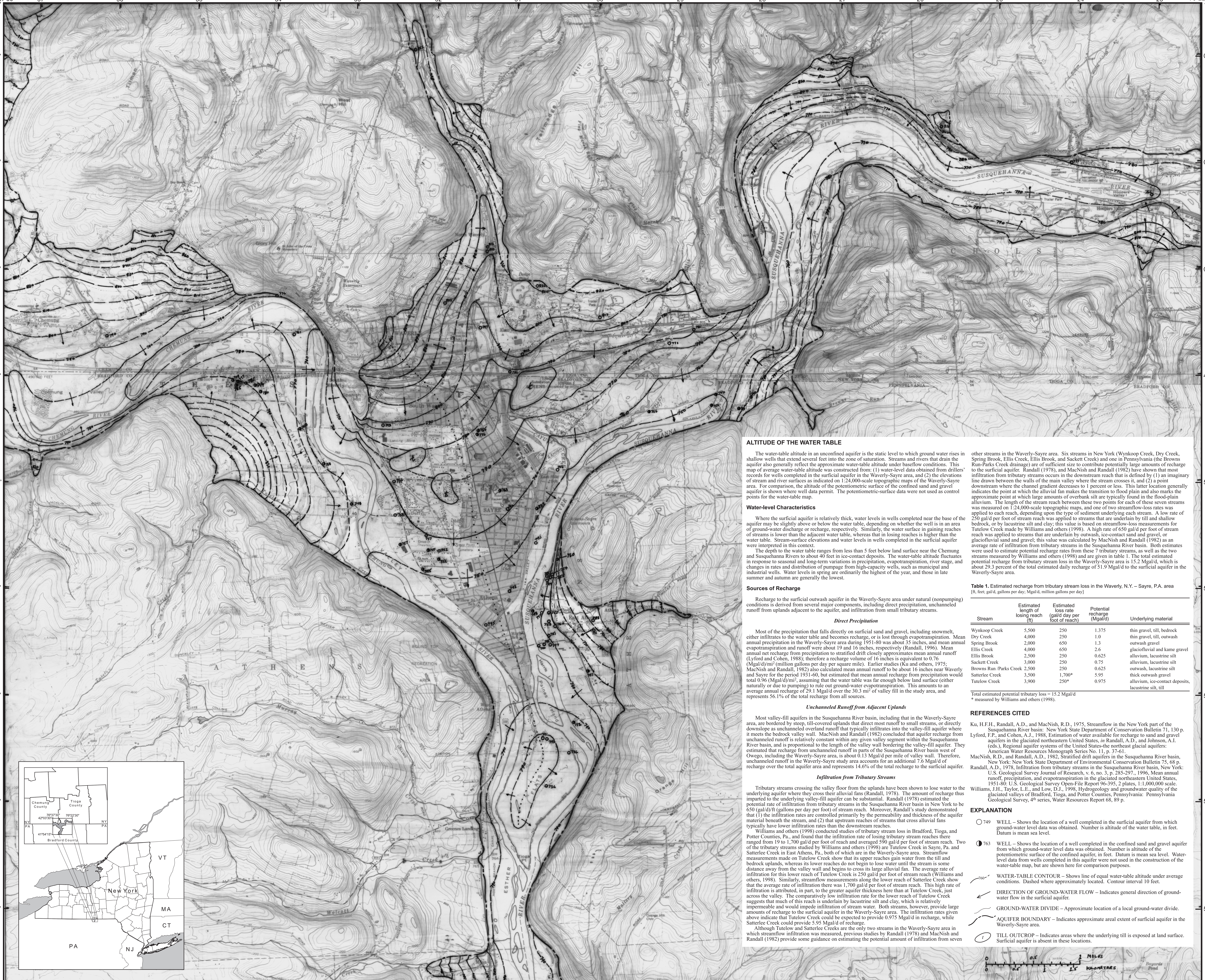
Reynolds, R.J., 2003, Hydrogeology of the Waverly-Sayre area in Tioga and Chemung Counties, New York and Bradford County, Pennsylvania: U.S. Geological Survey Open-File Report 02-284, 6 sheets, 1:24,000 scale.



ALTITUDE OF THE WATER TABLE

The water-table altitude in an unconfined aquifer is the static level to which ground water rises in shallow wells that extend several feet into the zone of saturation. Streams and rivers that drain the aquifer also generally reflect the approximate water-table altitude under baseflow conditions. This map of average water-table altitude was constructed from: (1) water-level data obtained from drillers' records for wells completed in the surficial aquifer in the Waverly-Sayre area, and (2) the elevations of stream and river surfaces as indicated on 1:24,000-scale topographic maps of the Waverly-Sayre area. For comparison, the altitude of the potentiometric surface of the confined sand and gravel aquifer is shown where well data permit. The potentiometric-surface data were not used as control points for the water-table map.

Water-level Characteristics

Where the surficial aquifer is relatively thick, water levels in wells completed near the base of the aquifer may be slightly above or below the water table, depending on whether the well is in an area of ground-water discharge or recharge, respectively. Similarly, the water surface in gaining reaches of streams is lower than the adjacent water table, whereas that in losing reaches is higher than the water table. Stream-surface elevations and water levels in wells completed in the surficial aquifer were interpreted in this context.

The depth to the water table ranges from less than 5 feet below land surface near the Chemung and Susquehanna Rivers to about 40 feet in ice-contact deposits. The water-table altitude fluctuates in response to seasonal and long-term variations in precipitation, evapotranspiration, river stage, and changes in rates and distribution of pumpage from high-capacity wells, such as municipal and industrial wells. Water levels in spring are ordinarily the highest of the year, and those in late summer and autumn are generally the lowest.

Sources of Recharge

Recharge to the surficial outwash aquifer in the Waverly-Sayre area under natural (nonpumping) conditions is derived from several major components, including direct precipitation, unchanneled runoff from uplands adjacent to the aquifer, and infiltration from small tributary streams.

Direct Precipitation

Most of the precipitation that falls directly on surficial sand and gravel, including snowmelt, either infiltrates to the water table and becomes recharge, or is lost through evapotranspiration. Mean annual precipitation in the Waverly-Sayre area during 1951-80 was about 35 inches, and mean annual evapotranspiration and runoff were about 19 and 16 inches, respectively (Randall, 1996). Mean annual net recharge from precipitation to stratified drift closely approximates mean annual runoff (Lyford and Cohen, 1988); therefore a recharge volume of 16 inches is equivalent to 0.76 $(Mgal/d)/mi^2$ (million gallons per day per square mile). Earlier studies (Ku and others, 1975; MacNish and Randall, 1982) also calculated mean annual runoff to be about 16 inches near Waverly and Sayre for the period 1931-60, but estimated that mean annual recharge from precipitation would total 0.96 $(Mgal/d)/mi^2$, assuming that the water table was far enough below land surface (either naturally or due to pumping) to rule out ground-water evapotranspiration. This amounts to an average annual recharge of 29.1 Mgal/d over the 30.3 mi^2 of valley fill in the study area, and represents 56.1% of the total recharge from all sources.

Unchanneled Runoff from Adjacent Uplands

Most valley-fill aquifers in the Susquehanna River basin, including that in the Waverly-Sayre area, are bordered by steep, till-covered uplands that direct most runoff to small streams, or directly downslope as unchanneled overland runoff that typically infiltrates into the valley-fill aquifer where it meets the bedrock valley wall. MacNish and Randall (1982) concluded that aquifer recharge from unchanneled runoff is relatively constant within any given valley segment within the Susquehanna River basin, and is proportional to the length of the valley wall bordering the valley-fill aquifer. They estimated that recharge from unchanneled runoff in parts of the Susquehanna River basin west of Owego, including the Waverly-Sayre area, is about 0.13 Mgal/d per mile of valley wall. Therefore, unchanneled runoff in the Waverly-Sayre study area accounts for an additional 7.6 Mgal/d of recharge over the total aquifer area and represents 14.6% of the total recharge to the surficial aquifer.

Infiltration from Tributary Streams

Tributary streams crossing the valley floor from the uplands have been shown to lose water to the underlying aquifer where they cross their alluvial fans (Randall, 1978). The amount of recharge thus imparted to the underlying valley-fill aquifer can be substantial. Randall (1978) estimated the potential rate of infiltration from tributary streams in the Susquehanna River basin in New York to be 650 (gal/d)/ft (gallons per day per foot) of stream reach. Moreover, Randall's study demonstrated that (1) the infiltration rates are controlled primarily by the permeability and thickness of the aquifer material beneath the stream, and (2) that upstream reaches of streams that cross alluvial fans typically have lower infiltration rates than the downstream reaches.

Williams and others (1998) conducted studies of tributary stream loss in Bradford, Tioga, and Potter Counties, Pa., and found that the infiltration rate of losing tributary stream reaches there ranged from 19 to 1,700 gal/d per foot of reach and averaged 590 gal/d per foot of stream reach. Two of the tributary streams studied by Williams and others (1998) are Tutelow Creek in Sayre, Pa. and Satterlee Creek in East Athens, Pa., both of which are in the Waverly-Sayre area. Streamflow measurements made on Tutelow Creek show that its upper reaches gain water from the till and bedrock uplands, whereas its lower reaches do not begin to lose water until the stream is some distance away from the valley wall and begins to cross its large alluvial fan. The average rate of infiltration for this lower reach of Tutelow Creek is 250 gal/d per foot of stream reach (Williams and others, 1998). Similarly, streamflow measurements along the lower reach of Satterlee Creek show that the average rate of infiltration there was 1,700 gal/d per foot of stream reach. This high rate of infiltration is attributed, in part, to the greater aquifer thickness here than at Tutelow Creek, just across the valley. The comparatively low infiltration rate for the lower reach of Tutelow Creek suggests that much of this reach is underlain by lacustrine silt and clay, which is relatively impermeable and would impede infiltration of stream water. Both streams, however, provide large amounts of recharge to the surficial aquifer in the Waverly-Sayre area. The infiltration rates given above indicate that Tutelow Creek could be expected to provide 0.975 Mgal/d in recharge, while Satterlee Creek could provide 5.95 Mgal/d of recharge.

Although Tutelow and Satterlee Creeks are the only two streams in the Waverly-Sayre area in which streamflow infiltration was measured, previous studies by Randall (1978) and MacNish and Randall (1982) provide some guidance on estimating the potential amount of infiltration from seven other streams in the Waverly-Sayre area. Six streams in New York (Wynkoop Creek, Dry Creek, Spring Brook, Ellis Creek, Ellis Brook, and Sackett Creek) and one in Pennsylvania (the Browns Run-Parks Creek drainage) are of sufficient size to contribute potentially large amounts of recharge to the surficial aquifer. Randall (1978), and MacNish and Randall (1982) have shown that most infiltration from tributary streams occurs in the downstream reach that is defined by (1) an imaginary line drawn between the walls of the main valley where the stream crosses it, and (2) a point downstream where the channel gradient decreases to 1 percent or less. This latter location generally indicates the point at which the alluvial fan makes the transition to flood plain and also marks the approximate point at which large amounts of overbank silt are typically found in the flood-plain alluvium. The length of the stream reach between these two points for each of these seven streams was measured on 1:24,000-scale topographic maps, and one of two streamflow-loss rates was applied to each reach, depending upon the type of sediment underlying each stream. A low rate of 250 gal/d per foot of stream reach was applied to streams that are underlain by till and shallow bedrock, or by lacustrine silt and clay; this value is based on streamflow-loss measurements for Tutelow Creek made by Williams and others (1998). A high rate of 650 gal/d per foot of stream reach was applied to streams that are underlain by outwash, ice-contact sand and gravel, or glaciofluvial sand and gravel; this value was calculated by MacNish and Randall (1982) as an average rate of infiltration from tributary streams in the Susquehanna River basin. Both estimates were used to estimate potential recharge rates from these 7 tributary streams, as well as the two streams measured by Williams and others (1998) and are given in table 1. The total estimated potential recharge from tributary stream loss in the Waverly-Sayre area is 15.2 Mgal/d, which is about 29.3 percent of the total estimated daily recharge of 51.9 Mgal/d to the surficial aquifer in the Waverly-Sayre area.

Table 1. Estimated recharge from tributary stream loss in the Waverly, N.Y. – Sayre, P.A. area
[ft, feet; gal/d, gallons per day; Mgal/d, million gallons per day]

Stream	Estimated length of losing reach (ft)	Estimated loss rate (gal/d day per foot of reach)	Potential recharge (Mgal/d)	Underlying material
Wynkoop Creek	5,500	250	1.375	thin gravel, till, bedrock
Dry Creek	4,000	250	1.0	thin gravel, till, outwash
Spring Brook	2,000	650	1.3	outwash gravel
Ellis Creek	4,000	650	2.6	glaciofluvial and kame gravel
Ellis Brook	2,500	250	0.625	alluvium, lacustrine silt
Sackett Creek	3,000	250	0.75	alluvium, lacustrine silt
Browns Run /Parks Creek	2,500	250	0.625	outwash, lacustrine silt
Satterlee Creek	3,500	1,700*	5.95	thick outwash gravel
Tutelow Creek	3,900	250*	0.975	alluvium, ice-contact deposits, lacustrine silt, till

Total estimated potential tributary loss = 15.2 Mgal/d
* measured by Williams and others (1998).

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EXPLANATION

749 WELL – Shows the location of a well completed in the surficial aquifer from which ground-water level data was obtained. Number is altitude of the water table, in feet. Datum is mean sea level.

763 WELL – Shows the location of a well completed in the confined sand and gravel aquifer from which ground-water level data was obtained. Number is altitude of the potentiometric surface of the confined aquifer, in feet. Datum is mean sea level. Water-level data from wells completed in this aquifer were not used in the construction of the water-table map, but are shown here for comparison purposes.

760 WATER-TABLE CONTOUR – Shows line of equal water-table altitude under average conditions. Dashed where approximately located. Contour interval 10 feet.

DIRECTION OF GROUND-WATER FLOW – Indicates general direction of ground-water flow in the surficial aquifer.

GROUND-WATER DIVIDE – Approximate location of a local ground-water divide.

AQUIFER BOUNDARY – Indicates approximate areal extent of surficial aquifer in the Waverly-Sayre area.

t TILL OUTCROP – Indicates areas where the underlying till is exposed at land surface. Surficial aquifer is absent in these locations.

Base from U.S. Geological Survey
1:24,000 Series: Waverly, NY-PA (1978);
Sayre, PA-NY (1969), Litchfield, PA-NY (1978)
Barton, NY-PA (1976)

HYDROGEOLOGY OF THE WAVERLY–SAYRE AREA IN TIOGA AND CHEMUNG COUNTIES, NEW YORK AND BRADFORD COUNTY, PENNSYLVANIA

By
Richard J. Reynolds
2003
Sheet 3 - Altitude of the Water Table

Hydrogeology by R. J. Reynolds, 2001

For additional information write to:
District Chief, U.S. Geological Survey, 425 Jordan Road, Troy, NY 12180

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