Estimates of Ground-Water Recharge Based on Streamflow-Hydrograph Methods: Pennsylvania

By Dennis W. Risser, Randall W. Conger, James E. Ulrich, and Michael P. Asmussen

In cooperation with the
Pennsylvania Department of Conservation and Natural Resources,
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Conversion Factors

Multiply	By	To obtain
Length		
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
Area		
square mile (mi^2)	2.590	square kilometer (km^2)
Volume		
cubic foot (ft^3)	0.02832	cubic meter (m^3)
Flow rate		
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Estimates of Ground-Water Recharge Based on Streamflow-Hydrograph Methods: Pennsylvania

By Dennis W. Risser, Randall W. Conger, James E. Ulrich, and Michael P. Asmussen[1]

Abstract

This study, completed by the U.S. Geological Survey (USGS) in cooperation with the Pennsylvania Department of Conservation and Natural Resources, Bureau of Topographic and Geologic Survey (T&GS), provides estimates of ground-water recharge for watersheds throughout Pennsylvania computed by use of two automated streamflow-hydrograph-analysis methods -- PART and RORA. The PART computer program uses a hydrograph-separation technique to divide the streamflow hydrograph into components of direct runoff and base flow. Base flow can be a useful approximation of recharge if losses and interbasin transfers of ground water are minimal. The RORA computer program uses a recession-curve displacement technique to estimate ground-water recharge from each storm period indicated on the streamflow hydrograph.

Recharge estimates were made using streamflow records collected during 1885-2001 from 197 active and inactive streamflow-gaging stations in Pennsylvania where streamflow is relatively unaffected by regulation. Estimates of mean-annual recharge in Pennsylvania computed by the use of PART ranged from 5.8 to 26.6 inches; estimates from RORA ranged from 7.7 to 29.3 inches. Estimates from the RORA program were about 2 inches greater than those derived from the PART program.

Mean-monthly recharge was computed from the RORA program and was reported as a percentage of mean-annual recharge. On the basis of this analysis, the major ground-water recharge period in Pennsylvania typically is November through May; the greatest monthly recharge typically occurs in March.

Introduction

Ground-water recharge is a fundamental component in the water budget of any watershed, but it is difficult to measure directly. Most often, recharge is estimated by indirect methods involving analysis of water budgets, fluctuation of ground-water levels, or streamflow hydrographs (Nimmo and others, 2003). In the humid eastern United States, most streams are gaining and the water table is near land surface, so the majority of ground-water recharge ultimately discharges as streamflow. Thus, streamflow hydrographs have been widely used to estimate recharge, either through a determination of base flow or analysis of the streamflow-recession data (Mau and Winter, 1997).

In recent years, interest in quantifying ground-water recharge rates in Pennsylvania has increased because of concerns that land-use changes may be reducing recharge and ground-water resources in rapidly developing areas may not be sustainable. In Pennsylvania, streamflow records are available from the U.S. Geological Survey (USGS) at 529 active or discontinued streamflow-gaging stations. Analysis of streamflow hydrographs from these stations could provide estimates of ground-water recharge for a considerable part of Pennsylvania.

This report provides estimates of ground-water recharge throughout Pennsylvania computed by use of two automated streamflow-hydrograph-analysis methods at 197 streamflow-gaging stations where streamflow is relatively unaffected by regulation (fig. 1). Ground-water recharge is reported for each station for the period of available record as (1) mean-annual recharge and (2) mean-monthly recharge. The scope of this report is limited to presenting the results from the two streamflow-hydrograph methods for the period of available record at each of the 197 stations.

Streamflow-Hydrograph Methods

Ground-water recharge was estimated from streamflow-hydrograph records by the use of two automated methods – PART and RORA (Rutledge, 1993, 1998). The PART computer program uses a hydrograph-separation technique to estimate base flow from the streamflow record. Although base flow is not recharge, it has been used as an approximation of recharge when the investigator believes that base flow represents ground-water discharge and that ground-water discharge is approximately equal to recharge. The RORA computer program uses the recession-curve displacement technique of Rorabaugh (1964) to estimate ground-water recharge from each

[1]Student volunteer for U.S. Geological Survey, 2004-2005.

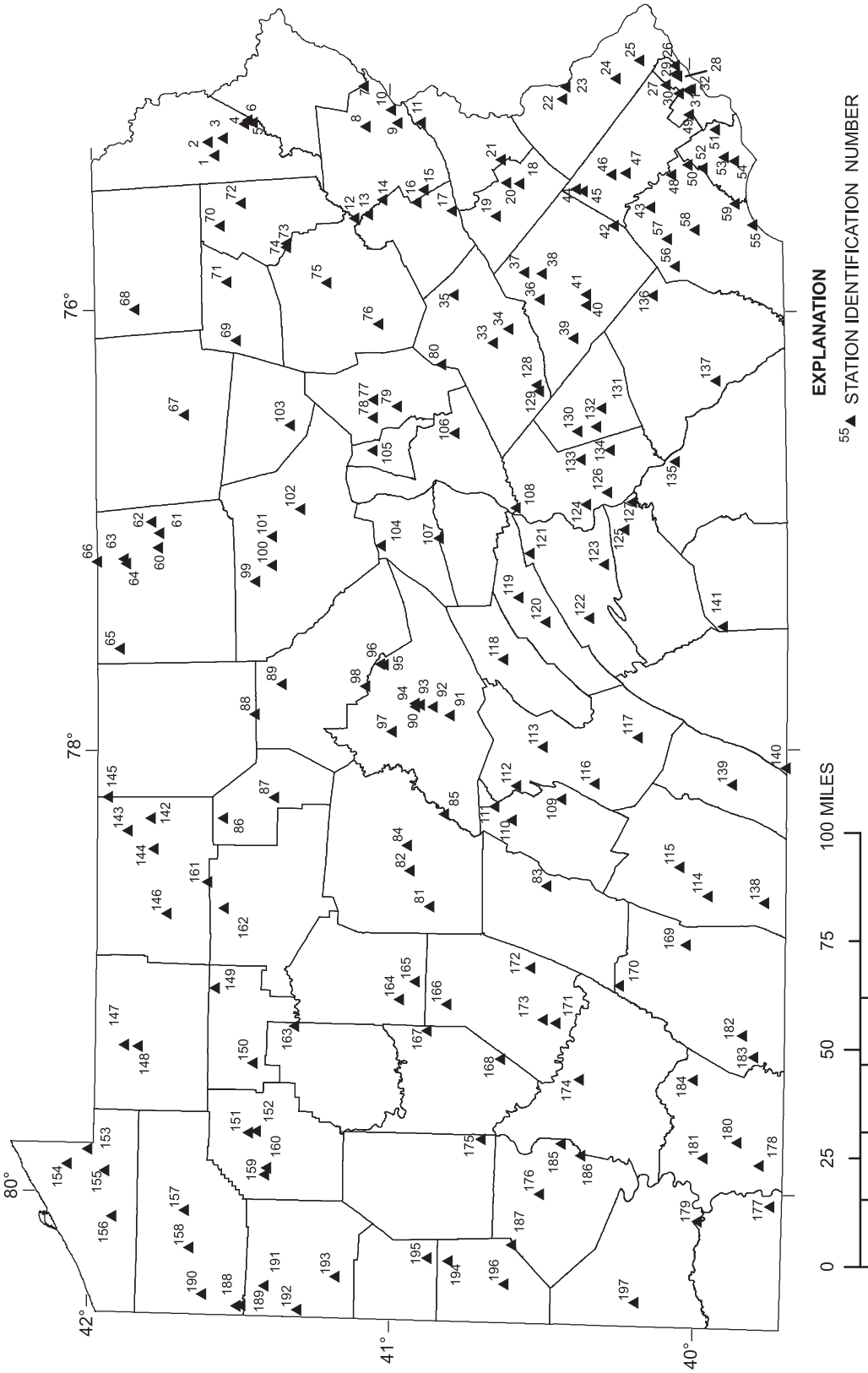

Figure 1. Streamflow-gaging stations in Pennsylvania where estimates of ground-water recharge were made.

storm period. The RORA program is not a hydrograph-separation method; rather, recharge is determined from displacement of the streamflow-recession curve according to the theory of ground-water drainage. The computer programs and documentation used for PART and RORA are available from the USGS (2005).

PART and RORA have the advantage of being able to estimate base flow or recharge with the use of daily mean values of streamflow from streamflow-gaging stations. The PART and RORA methods assume streamflow at some time after a storm represents ground-water discharge originating as spatially diffuse recharge. Snowmelt runoff, reservoir releases, and discharge of water from wetlands or bank storage are sources of water other than ground-water discharge that could contribute to streamflow during non-storm periods. It is incumbent on the user to evaluate how these sources could affect recharge estimates.

In this report, estimates of mean-annual recharge were reported for each streamflow-gaging station on the basis of base flow from the PART program and recharge from the RORA program. Mean-monthly recharge for each station was estimated by use of only RORA because base flow as determined from the PART program lags the timing of recharge.

Hydrograph Separation—PART Program

The computer program PART was used to provide estimates of base flow for selected gaged watersheds in Pennsylvania. Base flow is the part of streamflow usually attributed to ground-water discharge (U.S. Geological Survey, 1989). Although base flow is not recharge, it is sometimes used as an approximation of recharge when underflow, evapotranspiration from riparian vegetation, and other transfers of ground water to or from the watershed are minimal. If these conditions are met, base flow may provide a reasonable estimate of recharge for long time periods (1 year or more). When used as a proxy for recharge, base flow has sometimes been referred to as "effective recharge" (Daniel, 1996), "base recharge" (Szilagyi and others, 2003), or "observable recharge" (Holtschlag, 1997) to acknowledge that it probably represents some amount less than what recharged the aquifer.

Methods for separating streamflow hydrographs into components of base flow and surface runoff have been available for many years (Hall, 1968) and, more recently, computer programs have automated the separation procedures (Pettyjohn and Henning, 1979; Wahl and Wahl, 1988; Nathan and McMahon, 1990; Rutledge, 1993; Arnold and others, 1995). Application of different methods for separating base flow will provide different results. Because the separation of the streamflow hydrograph is subjective, the user is left to determine which estimate (if any) of the base-flow estimates is most representative of recharge. The computer program PART (Rutledge, 1998) was selected for this study because it has been widely used to compute base flow in the eastern United States (Rutledge and Mesko, 1996; Holtschlag, 1997; Nelms and others, 1997; Bachman and others, 1998) and the software is supported by the USGS.

The PART program computes base flow from the streamflow hydrograph by first identifying days of negligible surface runoff and assigning base flow equal to streamflow on those days; the program then interpolates between those days. PART locates periods of negligible surface runoff after a storm by identifying the days meeting a requirement of antecedent-recession length and rate of recession. It uses linear interpolation between the log values of base flow to connect across periods that do not meet those tests. A detailed description of the algorithm used by PART is provided in Rutledge (1998, p. 33-38). An example illustrating the separation of the base-flow component from a streamflow hydrograph is shown in figure 2.

Recession-Curve Displacement—RORA Program

The computer program RORA was used to provide estimates of annual and mean-monthly recharge from streamflow hydrographs at selected gaged watersheds in Pennsylvania. Although RORA uses streamflow data to estimate ground-water recharge, it is not a "hydrograph-separation" technique. It uses a recession-curve displacement method to estimate ground-water recharge from an equation developed by Rorabaugh (1964) for a one-dimensional analytical model of ground-water discharge to a fully penetrating stream in an idealized, homogenous aquifer with uniform spatial recharge. RORA has been used to estimate recharge for regional studies (Rutledge and Mesko, 1996; Flynn and Tasker, 2004), but because of the simplifying assumptions inherent in the equations, Halford and Mayer (2000) caution that RORA may not provide reasonable estimates of recharge for some watersheds.

For details regarding the theory and application of the recession-curve displacement method by the use of RORA, the reader is referred to Rutledge (1993, 1998, and 2000). However, the general procedure for estimating ground-water recharge with RORA is discussed below to illustrate the theoretical foundation of the method, which contrasts markedly to the more subjective hydrograph-separation method used in the PART program.

The recession-curve displacement method is based on the finding that at some critical time (t_c), after a streamflow peak, recharge from that storm can be computed as

$$R = \frac{2(Q_2 - Q_1)K}{2.3026} \times 86{,}400 \text{ sec/day}, \quad (1)$$

where

R is total volume of recharge for the streamflow peak, in cubic feet;

Q_1 is ground-water discharge at critical time (t_c) extrapolated from prestorm recession, in cubic feet per second;

Q_2 is ground-water discharge at critical time (t_c) extrapolated from poststorm recession, in cubic feet per second;

and

K is the recession index, defined as the time required for ground-water discharge to decline by one log cycle after the recession curve becomes nearly linear on a semilog hydrograph, in days.

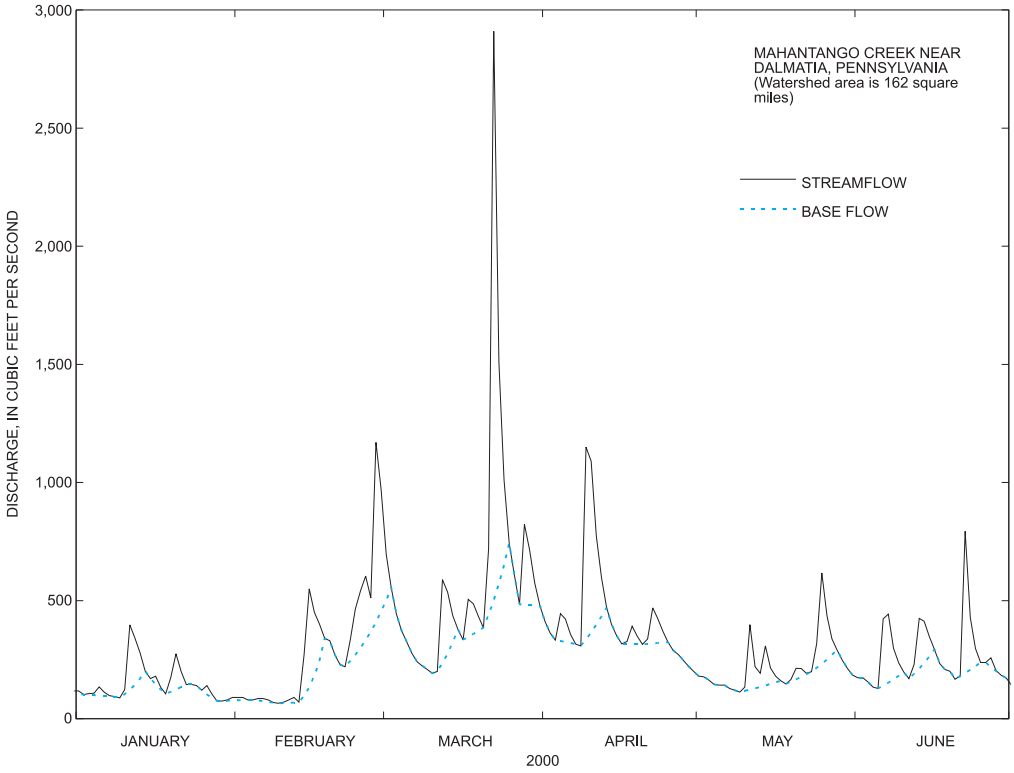

Figure 2. Streamflow hydrograph showing separation of the base-flow component with the PART program.

Critical time (t_c) is computed as $t_c = 0.2144K$, and the recession index (K) is determined by compilation of a master recession curve composed of numerous periods of streamflow recession (recession segments) for each streamflow-gaging station by the use of the RECESS program (Rutledge, 1998). In this study, recessions during June through August were not used to compile the master recession curve because of the possibility that evapotranspiration from ground water had steepened the slope of the recession curve. For consistency in approach, straight-line recession segments 7 to 17 days after storm peaks were used. Recession segments less than 7 days following a storm are probably prior to critical time (t_c), and the 10-day period was sufficiently long to define the recession index (K). Outlying recession segments (if any) were eliminated by examining the relation between the recession index (K) and the logarithm of median streamflow as discussed in RECESS (Rutledge, 1993, p. 17). If the plot showed a poor relation between the recession index (K) and streamflow, recharge was not estimated for that watershed.

An example of the recession-curve displacement method from Rutledge (1998) is illustrated in figure 3. In that example, Q_1 is 5 ft^3/s, Q_2 is 23 ft^3/s, K is 32 days, and the critical time is 6.86 days. From equation 1, ground-water recharge for that single event is 43.2 million ft^3. Recharge from that event could be expressed in inches by dividing by the watershed area upstream of the streamflow-gaging station. The computer program RORA automates the procedure illustrated in figure 3.

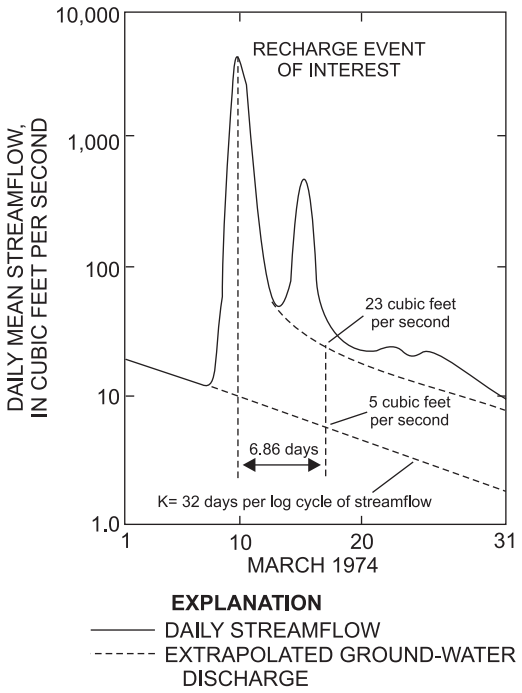

Figure 3. Procedure for estimating ground-water recharge by use of the recession-curve displacement method (from Rutledge, 1998, fig. 6).

Ground-Water Recharge Estimates

Ground-water recharge was estimated by the streamflow-hydrograph programs PART and RORA for selected streamflow-gaging stations in Pennsylvania. Estimates of mean-annual recharge from both methods for the period of available record are reported for each station. The seasonal variability of recharge is illustrated from estimates of the mean-monthly recharge from the RORA program expressed as a percentage of the mean-annual recharge for the period of record.

Selection of Streamflow-Gaging Stations

Recharge estimates were made using streamflow records collected during 1885-2001 from 197 active and inactive streamflow-gaging stations in Pennsylvania. The stations chosen for analysis had at least 10 years of record, recorded streamflow from watersheds of less than about 500 mi^2, and were relatively unaffected by upstream regulation from reservoirs, withdrawals, and wastewater return flow [to the extent that those conditions were indicated in the USGS annual data reports for Pennsylvania (*http://www.pa.water.usgs.gov/ar/index.html*)]. The selected streamflow-gaging stations are listed in table 1 (at the back of the report). The major rock types and land-use classes within each watershed upstream of the gaging station also are provided, which may be useful for evaluating differences in recharge among watersheds.

The period of record used for analysis of recharge from the streamflow-gaging stations varied from 10 to 92 years. At some stations, part of the available streamflow record was excluded from analysis if it was affected by regulation. For example, streamflow at the station on Bald Eagle Creek at Blanchard (01547500) in Centre County has been regulated by Foster Joseph Sayers Dam since 1971, so only streamflow record prior to 1971 was used in the recharge analysis. Of the 197 streamflow-gaging stations selected for analysis, 80 stations had 10 to 20 years of usable record available and 88 stations had more than 30 years of usable record (fig. 4; table 1).

Mean-Annual Recharge

Estimates of mean-annual recharge computed by the use of PART and RORA for the period of unregulated streamflow recorded through 2001 are given in table 2 (at the back of the report). Estimates of mean-annual recharge computed by the use of PART ranged from 5.8 to 26.6 in.; estimates from RORA ranged from 7.7 to 29.3 in. Because the estimates were not derived for a common period of record, comparison of results among stations could be affected by differing climatic periods. The number of streamflow-gaging stations used in the recharge analysis for each year is shown in figure 5. The period 1960-2001 is most heavily represented in the analysis.

Estimates of mean-annual ground-water recharge from the RORA method are about 2 in. greater than those derived from the PART program (fig. 6). Rutledge and Mesko (1996) reported a similar difference between the methods for watersheds in the Piedmont and Valley and Ridge Physiographic Provinces. Because the RORA and PART programs represent very different approaches for estimating recharge from the streamflow hydrograph, it is not surprising the results differ. In some cases, RORA seems to provide an unreasonably large estimate of recharge that is nearly equal to streamflow. For streamflow-gaging station Spring Creek at Milesburg (station 01547100) in Centre County, recharge estimated by RORA actually exceeded the amount of streamflow recorded (table 2).

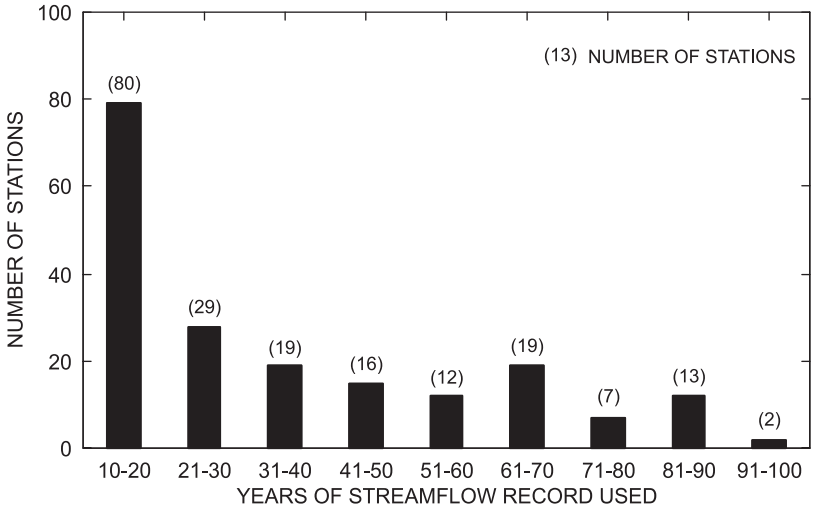

Figure 4. Number of streamflow-gaging stations categorized by years of record used in the recharge analysis.

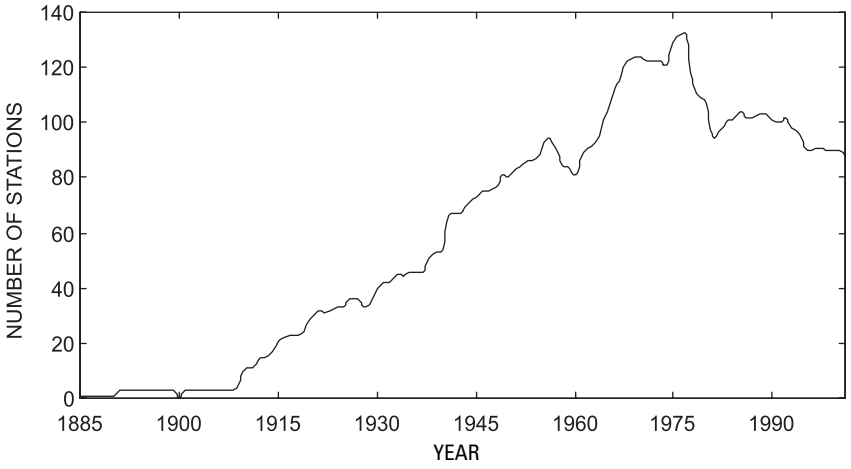

Figure 5. Number of streamflow-gaging stations used in the analysis of recharge, by year, 1885-2001.

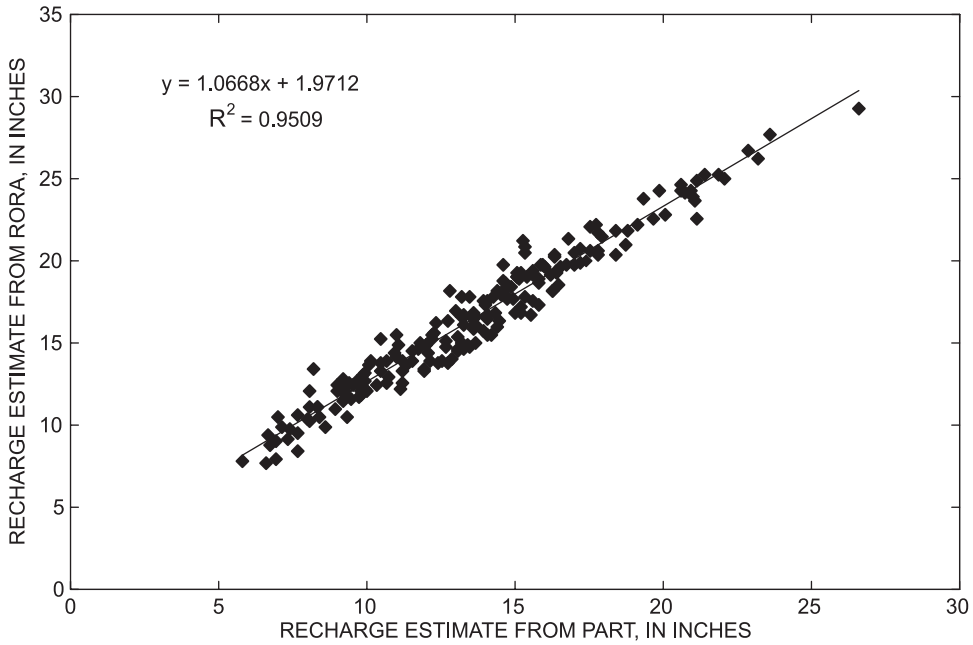

Figure 6. Comparison of mean-annual recharge between PART and RORA programs for 197 streamflow-gaging stations in Pennsylvania.

Mean-Monthly Recharge

To provide an estimate of the seasonal variability in recharge for watersheds in Pennsylvania, the mean-monthly recharge from the RORA program was reported at all 197 streamflow-gaging stations. Mean-monthly recharge is the mean of all recharge values for a particular month for the period of record. Only estimates from RORA were reported because they theoretically represent the volume of water that recharged the aquifer from individual storm events, whereas the PART program provides an estimate of monthly base flow, which lags the timing of recharge.

Mean-monthly recharge is given in table 3 (at the back of the report) as a percentage of the mean-annual recharge computed from RORA. The recharge is expressed as a percentage so that it can be used to derive seasonal estimates of recharge from the long-term mean-annual recharge obtained from PART, RORA, or any other method. Mean-monthly recharge as a percentage of mean-annual recharge was averaged for all 197 stations (fig. 7). The monthly values indicate the major ground-water recharge period in Pennsylvania typically occurs in

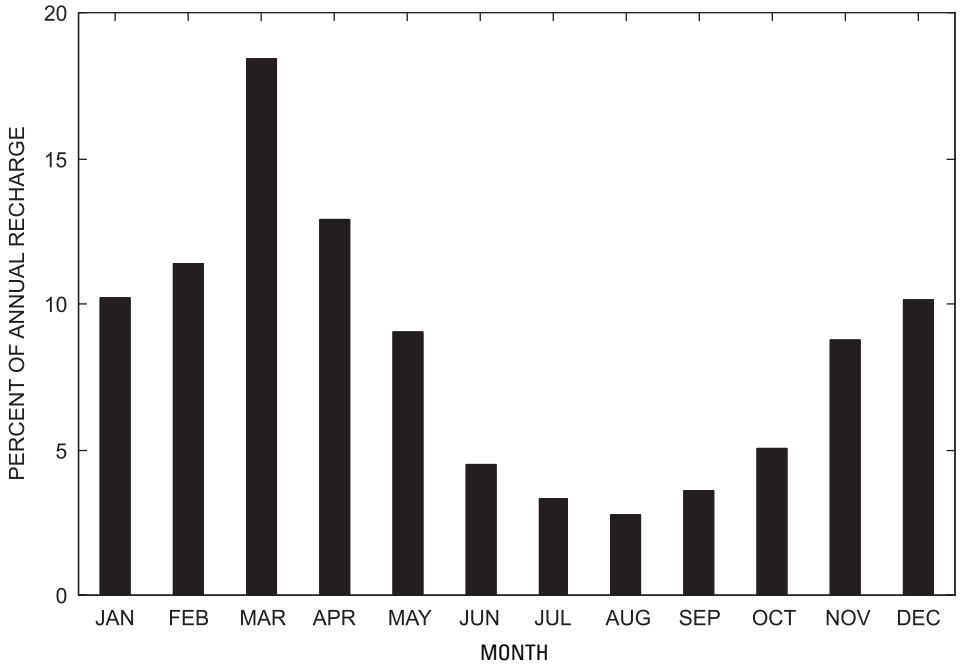

Figure 7. Average of mean-monthly recharge determined from RORA for 197 streamflow-gaging stations, expressed as a percentage of mean-annual recharge from RORA.

November through May, during which about 80 percent of the annual recharge occurs. About 18 percent of the annual recharge typically occurs in March, the month of greatest recharge, on average.

Estimates of mean-monthly recharge from RORA are probably less reliable than estimates for longer periods. Rutledge (2000, p. 31) recommends that results from RORA not be reported at time scales smaller than seasonal (3 months), because results differ most greatly from manual application of the recession-curve displacement method at small time scales. Because the mean-monthly estimates of recharge given in this report are average values for at least 10 years of record, the effect of errors in estimates of recharge for individual months by RORA should be lessened, although this has not been tested. Estimates of recharge for 3-month (or longer) periods can be derived by averaging the appropriate mean-monthly values.

Summary

This study, completed by the U.S. Geological Survey (USGS) in cooperation with the Pennsylvania Department of Conservation and Natural Resources, Bureau of Topographic and Geologic Survey (T&GS), provides estimates of groundwater recharge for watersheds throughout Pennsylvania computed by use of two automated streamflow-hydrograph-analysis methods—PART and RORA. Recharge estimates were made using streamflow records collected during 1885-2001 from 197 active and inactive streamflow-gaging stations in Pennsylvania. The stations chosen for analysis had at least 10 years of record, recorded discharge from watersheds of less than about 500 mi^2, and were relatively unaffected by upstream regulation from reservoirs, withdrawals, and wastewater return flow.

The PART computer program provides an estimate of base flow from the streamflow record by use of a hydrograph-separation technique. Although base flow is not recharge, it can be used as an estimate of recharge if it can be assumed that base flow represents ground-water discharge and that losses or transfers of ground water from the watershed are minimal. The RORA computer program uses a recession-curve displacement technique to estimate ground-water recharge from each storm period. It is based on a one-dimensional analytical model of ground-water discharge to a fully penetrating stream in an idealized aquifer with uniform spatial recharge. The recession index (K) required by the RORA program was determined by the use of the RECESS program. In this study, recessions during June through August were excluded from the analysis of recession index because of the possibility that evapotranspiration from ground water had steepened the slope of the recession curve. For consistency in approach, each recession segment was chosen from 7 to 17 days after the storm peak.

Estimates of annual recharge in Pennsylvania computed by the use of PART and RORA ranged from 5.8 to 29.3 in. Because the estimates were not derived for a common period of record, comparison of results among stations might be affected by differing climatic conditions when the stations were in operation. Estimates of mean-annual ground-water recharge from RORA are about 2 in. greater than those derived from the PART

program, and for one watershed, provided estimates of recharge that exceeded streamflow.

Mean-monthly recharge was computed from RORA and reported as a percentage of mean-annual recharge. Average mean-monthly recharge for all 197 stations indicates the major ground-water recharge period in Pennsylvania is November through May; the greatest monthly recharge occurs in March.

Acknowledgments

The Pennsylvania Department of Conservation and Natural Resources, Bureau of Topographic and Geologic Survey (T&GS) is gratefully acknowledged for providing support for this project. Thanks are extended to colleagues who provided technical review of the report -- Michael Moore, Gary Fleeger, Stuart Reese, and Thomas McElroy of T&GS; and Kevin Breen, Kim Otto, Douglas Chichester, and Ronald Thompson of USGS.

References Cited

Arnold, J.G., Allen, P.M., Muttiah, R., and Bernhardt, G., 1995, Automated base flow separation and recession analysis techniques: Ground Water, v. 33, no. 6, p. 1010-1018.

Bachman, J.L., Lindsey, B.D., Brakebill, J.W., and Powars, D.S., 1998, Ground-water discharge and base-flow nitrate loads of nontidal streams, and their relation to a hydrogeomorphic classification of the Chesapeake Bay Watershed, middle Atlantic Coast: U.S. Geological Survey Water-Resources Investigations Report 98-4059, 71 p.

Berg, T.M., Edmunds, W.E., Gryer, A.R., and others, 1980, Geologic map of Pennsylvania: 2nd ed., scale 1:250,000.

Daniel, C.C., III, 1996, Ground-water recharge to the regolith-fractured crystalline rock aquifer system, Orange County, North Carolina: U.S. Geological Survey Water-Resources Investigations Report 96-4220, 59 p.

Flynn, R.H., and Tasker, G.D., 2004, Generalized estimates from streamflow data of annual and seasonal ground-water-recharge rates for drainage basins in New Hampshire: U.S. Geological Survey Scientific Investigations Report 2004-5019, 61 p.

Halford, K.J., and Mayer, G.C., 2000, Problems associated with estimating ground-water discharge and recharge from stream-discharge records: Ground Water, v. 38, no. 3, p. 331-342.

Hall, F.R., 1968, Base-flow recessions–a review: Water Resources Research, v. 4, no. 5, p. 973-983.

Holtschlag, D.J., 1997, A generalized estimate of ground-water recharge rates in the Lower Peninsula of Michigan: U.S. Geological Survey Water-Supply Paper 2437, 37 p.

Mau, D.P., and Winter, T.C., 1997, Estimating ground-water recharge from streamflow hydrographs for a small mountain watershed in a temperate humid climate, New Hampshire, USA: Ground Water, v. 35, no. 2, p. 291-304.

Nathan, R.J., and McMahon, T.A., 1990, Evaluation of automated techniques for base flow and recession analyses: Water Resources Research, v. 26, no 7, p. 1465-1473.

Nelms, D.L., Harlow, G.E., Jr., and Hayes, D.C., 1997, Base-flow characteristics of streams in the Valley and Ridge, the Blue Ridge, and the Piedmont Physiographic Provinces of Virginia: U.S. Geological Survey Water-Supply Paper 2457, 48 p.

Nimmo, J.R., Stonestrom, David, and Healy, R.W., 2003, Aquifer recharge: Encyclopedia of Water Science, Marcel Dekker, Inc., p. 1-4.

Pettyjohn, W.A., and Henning, Roger, 1979, Preliminary estimate of ground-water recharge rates, related streamflow and water quality in Ohio: Ohio State University Water Resources Center Project Completion Report Number 552, 323 p.

Rorabaugh, M.I., 1964, Estimating changes in bank storage and ground-water contribution to streamflow: Extract of publication no. 63 of the I.A.S.H. Symposium Surface Waters, p. 432-441.

Rutledge, A.T., 1993, Computer programs for describing the recession of ground-water discharge and for estimating mean ground-water recharge and discharge from streamflow records: U.S. Geological Survey Water-Resources Investigations Report 93-4121, 45 p.

Rutledge, A.T., 1998, Computer programs for describing the recession of ground-water discharge and for estimating mean ground-water recharge and discharge from streamflow records—update: U.S. Geological Survey Water-Resources Investigations Report 98-4148, 43 p.

Rutledge, A.T., 2000, Considerations for use of the RORA program to estimate ground-water recharge from streamflow records: U.S. Geological Survey, Open-File Report 00-156, 44 p.

Rutledge, A.T., and Mesko, T.O., 1996, Estimated hydrologic characteristics of shallow aquifer systems in the Valley and Ridge, the Blue Ridge, and the Piedmont Physiographic Provinces based on analysis of streamflow recession and base flow: U.S. Geological Survey Professional Paper 1422-B, 58 p.

Szilagyi, Jozef, Harvey, F.E., and Ayers, J.F., 2003, Regional estimation of base recharge to ground water using water balance and a base-flow index: Ground Water, v. 41, no. 4, p. 504-513.

U.S. Geological Survey, 1989, Federal Glossary of selected terms – subsurface-water flow and solute transport: U.S. Geological Survey, Office of Water Data Coordination, Ground Water Subcommittee of the Federal Interagency Advisory Committee on Water Data, 38 p.

U.S. Geological Survey, 2005, Water resources application software—USGS ground-water software: accessed July 26, 2005, at *http://water.usgs.gov/software/ground_water.html*.

Vogelmann, J.E., S.M. Howard, L. Yang, C.R. Larson, B.K. Wylie, N. Van Driel, 2001. Completion of the 1990s National Land Cover Data Set for the Conterminous United States from Landsat Thematic Mapper Data and Ancillary Data Sources: Photogrammetric Engineering and Remote Sensing, v. 67, no. 6, p. 650-652.

Wahl, K.L., and Wahl, T.L., 1988, BFI—A computer program for determining an index to base flow: U.S. Bureau of Reclamation Water Resources Research Laboratory, accessed August 25, 2004, at *http://www.usbr.gov.pmts.hydraulics_lab/twahl/bfi/*.

Table 1. Streamflow-gaging stations used to estimate ground-water recharge in Pennsylvania, with generalized rock types and land-use classes for watershed.

Map identification number (fig. 1)	Station identification number	Station name	Drainage area (square miles)	Period of record used			Rock type[1] (percent of basin)				Land-use classes[2] (percent of basin)			
				Start	End	Number of years	Siliciclastic	Carbonate	Crystalline	Unconsolidated	Forest	Agriculture	Developed	Other
1	01429000	West Branch Lackawaxen River at Prompton	59.7	1945	1960	16	100.0	0	0	0	73.6	22.2	0.4	3.8
2	01429500	Dyberry Creek near Honesdale	64.6	1944	1959	16	100.0	0	0	0	83.2	13.8	.5	2.5
3	01430000	Lackawaxen River near Honesdale	164	1949	1959	11	100.0	0	0	0	75.2	18.9	1.6	4.3
4	01430500	Lackawaxen River at West Hawley	206	1923	1937	15	100.0	0	0	0	74.6	19.2	1.9	4.4
5	01431500	Lackawaxen River at Hawley	290	1909/16	1939/59	29	100.0	0	0	0	74.1	18.7	1.7	5.5
6	01432000	Wallenpaupack Creek at Wilsonville	228	1910	1925	16	100.0	0	0	0	75.7	8.6	4.6	11.1
7	01439500	Bush Kill At Shoemakers	117	1909	2000	92	100.0	0	0	0	84.1	.4	3.8	11.7
8	01440400	Brodhead Creek near Analomink	65.9	1958	2001	44	100.0	0	0	0	88.8	1.4	4.2	5.6
9	01441000	McMichael Creek near Stroudsburg	65.3	1912	1937	26	99.8	.2	0	0	73.8	19.0	3.6	3.6
10	01442500	Brodhead Creek near Minisink	259	1951	2001	51	99.9	.1	0	0	79.6	7.2	8.6	4.5
11	01446600	Martins Creek near East Bangor	10.4	1962	1977	16	100.0	0	0	0	79.7	12.4	.1	7.8
12	01447500	Lehigh River at Stoddartsville	91.7	1944	2001	58	100.0	0	0	0	76.6	.9	7.6	14.9
13	01447720	Tobyhanna Creek near Blakeslee	118	1962	1985	24	100.0	0	0	0	68.0	2.6	10.9	18.5
14	01448500	Dilldown Creek near Long Pond	2.4	1949	1995	47	100.0	0	0	0	93.3	1.1	.5	5.1
15	01449360	Pohopoco Creek at Kresgeville	49.9	1967	2001	35	100.0	0	0	0	64.4	26.2	7.3	2.1
16	01449500	Wild Creek at Hatchery	16.8	1941	1958	18	100.0	0	0	0	93.1	.5	.6	5.8
17	01450500	Aquashicola Creek at Palmerton	76.7	1940	2001	62	95.1	4.9	0	0	67.3	23.2	3.1	6.4
18	01451500	Little Lehigh Creek near Allentown	80.8	1946	2001	56	9.0	63.7	27.3	0	30.9	54.4	13.8	1.0
19	01451800	Jordan Creek near Schecksville	53	1967	2001	35	100.0	0	0	0	32.7	64.9	1.8	.6
20	01452000	Jordan Creek at Allentown	75.8	1945	2001	57	88.7	11.3	0	0	32.1	62.0	4.9	1.0
21	01452500	Monocacy Creek at Bethlehem	44.5	1949	2001	53	35.6	62.8	1.5	0	17.8	66.2	13.4	2.7
22	01459500	Tohickon Creek near Pipersville	97.4	1936	1973	38	66.3	0	33.7	0	57.7	31.7	4.9	5.8
23	01460000	Tohickon Creek at Point Pleasant	107	1891/1901	1899/1913	22	70.4	0	29.6	0	57.2	33.1	4.5	5.2
24	01465000	Neshaminy Creek at Rushland	134	1891/1901	1899/1913	22	100.0	0	0	0	32.7	36.2	29.8	1.3
25	01465500	Neshaminy Creek near Langhorne	210	1935	2001	67	95.6	1.8	2.6	0	31.9	37.5	28.7	1.8
26	01465798	Poquessing Creek at Grant Avenue	21.4	1966	2001	36	0	1.0	67.0	32.0	9.0	7.6	80.7	2.8
27	01467042	Pennypack Creek at Pine Road	37.9	1965	1980	16	49.9	1.9	48.2	0	15.0	2.6	81.4	1.0
28	01467048	Pennypack Creek at Lower Rhawn Street Bridge	49.8	1966	2000	35	38.0	1.4	57.4	3.2	14.6	2.2	82.2	1.1

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Map identification number (fig. 1)	Station identification number	Station name	Drainage area (square miles)	Period of record used			Rock type[1] (percent of basin)				Land-use classes[2] (percent of basin)			
				Start	End	Number of years	Siliciclastic	Carbonate	Crystalline	Unconsolidated	Forest	Agriculture	Developed	Other
29	01467050	Wooden Bridge Run at Philadelphia	3.4	1966	1980	15	0	0	55.4	44.6	13.6	4.1	81.4	0.9
30	01467086	Tacony Creek above Adams Ave	16.6	1966	1985	20	0	0	97.7	2.3	6.3	0	93.1	.6
31	01467087	Frankford Creek at Castor Avenue	30.4	1983	2001	19	0	0	87.1	13.0	5.8	0	93.9	.4
32	01467089	Frankford Creek at Torresdale Avenue	33.8	1966	1980	15	0	0	82.7	17.4	5.2	0	94.4	.4
33	01467500	Schuylkill River at Pottsville	53.4	1944	1968	25	100.0	0	0	0	76.6	1.0	8.3	14.1
34	01468500	Schuylkill River at Landingville	133.0	1974	2001	28	100.0	0	0	0	72.9	4.4	10.1	12.5
35	01469500	Little Schuylkill River at Tamaqua	42.9	1920	2001	82	100.0	0	0	0	75.8	14.7	4.5	5.0
36	01470500	Schuylkill River at Berne	355	1948	2001	54	99.9	.1	0	0	71.1	14.5	6.6	7.7
37	01470720	Maiden Creek Tributary at Lenhartsville	7.5	1966	1980	15	100.0	0	0	0	29.6	68.8	1.3	.4
38	01470756	Maiden Creek at Virginville	159	1974	1994	21	84.4	10.8	4.8	0	41.4	56.1	1.4	1.1
39	01470779	Tulpehocken Creek near Bernville	66.5	1975	2001	27	13.1	83.3	3.6	0	12.7	81.7	4.5	1.0
40	01470960	Tulpehocken Creek at Blue Marsh Damsite	175	1966	1978	13	50.2	42.1	7.8	0	26.3	68.6	3.1	2.1
41	01471000	Tulpehocken Creek near Reading	211	1951	1978	28	50.6	41.3	8.2	0	27.3	66.8	4.0	1.9
42	01471980	Manatawny Creek near Pottstown	85.5	1975	2001	27	14.5	26.2	59.3	0	54.8	41.4	2.2	1.5
43	01472157	French Creek near Phoenixville	59.1	1969	2001	33	30.8	.6	68.6	0	62.4	34.4	1.8	1.4
44	01472198	Perkiomen Creek at East Greenville	38	1982	2001	20	32.7	3.3	64.0	0	51.2	44.1	2.9	1.7
45	01472199	West Branch Perkiomen Creek at Hillegass	23	1982	2001	20	35.0	4.8	60.3	0	59.1	36.1	3.4	1.5
46	01472500	Perkiomen Creek near Frederick	152	1885/1901	1899/1913	28	50.9	1.6	47.5	0	57.4	35.9	4.1	2.6
47	01473000	Perkiomen Creek at Graterford	279	1915	1956	42	67.0	1.3	31.7	0	49.2	42.1	7.1	1.7
48	01473169	Valley Creek at PA Turnpike Br near Valley Forge	20.8	1983	2001	19	0	66.9	32.8	.3	35.2	15.6	45.7	3.4
49	01474000	Wissahickon Creek at Mouth Philadelphia	64	1966	2001	36	53.3	16.0	29.7	1.0	26.7	10.0	62.5	.9
50	01475300	Darby Creek at Waterloo Mills near Devon	5.1	1973	1993	21	0	0	100.0	0	25.2	7.3	67.3	.3
51	01475510	Darby Creek near Darby	37.4	1965	1989	25	0	0	90.1	9.9	15.4	6.0	78.3	.4
52	01475850	Crum Creek near Newtown Square	15.8	1982	2001	20	0	0	100.0	0	47.7	20.1	31.9	.4
53	01476500	Ridley Creek at Moylan	31.9	1932	1953	22	0	0	98.3	1.7	47.6	24.9	27.2	.3

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Map identification number (fig. 1)	Station identification number	Station name	Drainage area (square miles)	Period of record used			Rock type[1] (percent of basin)				Land-use classes[2] (percent of basin)			
				Start	End	Number of years	Siliciclastic	Carbonate	Crystalline	Unconsolidated	Forest	Agriculture	Developed	Other
54	01477000	Chester Creek near Chester	61.1	1932	2001	70	0	0	99.8	0.2	37.4	23.0	38.6	1.1
55	01479820	Red Clay Creek near Kennett Square	28.3	1988	2001	14	0	11.1	88.9	0	30.0	50.5	18.0	1.6
56	01480300	West Branch Brandywine Creek near Honey Brook	18.7	1961	2001	41	0	3.4	96.6	0	24.5	70.0	2.6	2.9
57	01480675	Marsh Creek near Glenmoore	8.6	1967	2001	35	0	.4	99.6	0	53.2	41.3	1.5	4.1
58	01480800	East Branch Brandywine Creek at Downingtown	81.6	1959	1967	9	0	6.7	93.3	0	43.0	45.7	9.4	2.0
59	01481000	Brandywine Creek at Chadds Ford	287	1912/63	1952/01	80	0	7.6	92.4	0	40.1	44.6	14.0	1.4
60	01516350	Tioga River near Mansfield	153	1977	2001	25	100.0	0	0	0	73.7	23.1	2.0	1.2
61	01516500	Corey Creek near Mainesburg	12.2	1955	2001	47	100.0	0	0	0	47.5	52.0	.1	.4
62	01517000	Elk Run near Mainesburg	10.2	1955	1977	23	100.0	0	0	0	50.6	49.3	.1	.1
63	01518000	Tioga River at Tioga	282	1939	1976	38	100.0	0	0	0	65.6	31.6	1.7	1.1
64	01518500	Crooked Creek at Tioga	122	1954	1973	20	100.0	0	0	0	60.3	37.9	.5	1.3
65	01518862	Cowanesque River at Westfield	90.6	1984	2001	18	100.0	0	0	0	62.7	36.0	1.1	.2
66	01520000	Cowanesque River near Lawrenceville	298	1952	1979	28	100.0	0	0	0	62.0	36.6	.8	.6
67	01532000	Towanda Creek near Monroeton	215	1915	2001	87	100.0	0	0	0	66.9	31.9	.6	.6
68	01532850	Main Branch Wyalusing Creek near Birchardville	5.7	1966	1978	13	100.0	0	0	0	78.3	21.1	.1	.5
69	01533500	North Branch Mehoopany Creek near Lovelton	35.2	1941	1957	17	100.0	0	0	0	81.1	17.9	.1	.9
70	01533950	South Branch Tunkhannock Creek near Montdale	12.6	1961	1977	17	100.0	0	0	0	71.1	22.3	2.1	4.4
71	01534000	Tunkhannock Creek near Tunkhannock	383	1915	2001	87	100.0	0	0	0	65.9	27.5	3.1	3.5
72	01534500	Lackawanna River at Archbald	108	1941	1959	19	100.0	0	0	0	78.2	9.7	7.8	4.3
73	01535500	Lackawanna River at Moosic	264	1914	1927	14	100.0	0	0	0	67.0	7.8	20.0	5.3
74	01536000	Lackawanna River at Old Forge	332	1939	1959	21	100.0	0	0	0	68.7	7.5	18.1	5.7
75	01537500	Solomon Creek at Wilkes-Barre	15.7	1941	1989	49	100.0	0	0	0	66.6	2.0	26.3	5.1
76	01538000	Wapwallopen Creek near Wapwallopen	43.8	1920	2001	82	100.0	0	0	0	74.7	9.6	11.2	4.5
77	01539000	Fishing Creek near Bloomsburg	274	1939	2001	63	100.0	0	0	0	72.5	26.3	.7	.6
78	01539500	Little Fishing Creek at Eyers Grove	56.5	1941	1957	17	100.0	0	0	0	64.5	34.7	.7	.2

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				Start	End	Number of years	Siliciclastic	Carbonate	Crystalline	Unconsolidated	Forest	Agriculture	Developed	Other
79	01540000	Fishing Creek at Bloomsburg	355	1915	1927	13	99.9	0.1	0	0	68.5	30.0	1.0	0.5
80	01540200	Trexler Run near Ringtown	1.8	1964	1980	17	100.0	0	0	0	90.0	9.5	0	.5
81	01541000	West Branch Susquehanna River at Bower	315	1914	2001	88	100.0	0	0	0	76.8	18.5	1.8	2.9
82	01541200	West Branch Susquehanna River near Curwensville	367	1956	1965	10	100.0	0	0	0	77.9	17.2	1.6	3.3
83	01541308	Bradley Run near Ashville	6.8	1968	1979	12	100.0	0	0	0	83.8	3.9	11.6	.8
84	01541500	Clearfield Creek at Dimeling	371	1914	2001	88	100.0	0	0	0	80.2	13.5	1.5	4.8
85	01542000	Moshannon Creek at Osceola Mills	68.8	1941	1992	52	100.0	0	0	0	81.3	6.6	3.4	8.7
86	01542810	Waldy Run near Emporium	5.2	1965	2001	37	100.0	0	0	0	99.3	.7	0	0
87	01543000	Driftwood Br Sinnemahoning Creek at Sterling Run	272	1914	2001	88	100.0	0	0	0	96.4	2.5	.8	.3
88	01544500	Kettle Creek At Cross Fork	136.0	1941	2001	61	100.0	0	0	0	96.0	3.8	.2	.1
89	01545600	Young Womans Creek near Renovo	46.2	1965	2001	37	100.0	0	0	0	99.6	.3	.1	0
90	01546000	North Bald Eagle Creek at Milesburg	119	1912	1927	16	92.5	7.5	0	0	84.8	13.7	.8	.7
91	01546400	Spring Creek at Houserville	58.5	1985	2001	17	24.9	75.1	0	0	37.0	50.7	11.9	.4
92	01546500	Spring Creek near Axemann	87.2	1941	2001	61	16.9	83.1	0	0	35.1	52.0	12.4	.5
93	01547100	Spring Creek at Milesburg	175	1968	2001	34	21.7	78.3	0	0	39.4	50.1	9.8	.6
94	01547200	Bald Eagle Creek below Spring Creek at Milesburg	265	1956	2001	46	54.0	46.0	0	0	60.0	33.5	5.8	.7
95	01547500	Bald Eagle Creek at Blanchard	339	1955	1970	16	55.4	44.6	0	0	59.8	33.4	5.2	1.6
96	01547700	Marsh Creek at Blanchard	44.1	1956	2001	46	99.6	.4	0	0	77.6	21.5	.8	.1
97	01547800	South Fork Beech Creek near Snow Shoe	12.2	1970	1980	11	100.0	0	0	0	96.9	.3	2.6	.2
98	01547950	Beech Creek at Monument	152	1969	2001	33	100.0	0	0	0	91.8	.8	.8	6.6
99	01549500	Blockhouse Creek near English Center	37.7	1941	2001	61	100.0	0	0	0	77.7	21.3	.9	.1
100	01549780	Larrys Creek at Cogan House	6.8	1961	1977	17	99.9	0	0	0	73.4	26.3	.3	0
101	01550000	Lycoming Creek near Trout Run	173	1914	2001	88	100.0	0	0	0	85.2	13.9	.5	.5
102	01552000	Loyalsock Creek at Loyalsockville	435	1926/73	1976/01	74	100.0	0	0	0	88.1	10.1	.7	1.2
103	01552500	Muncy Creek near Sonestown	23.8	1941	2001	61	100.0	0	0	0	92.2	5.0	2.6	.2

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				Start	End	Number of years	Siliciclastic	Carbonate	Crystalline	Unconsolidated	Forest	Agriculture	Developed	Other
104	01553130	Sand Spring Run near White Deer	4.9	1968	1980	13	100.0	0	0	0	95.1	1.5	3.4	0
105	01553600	East Branch Chillisquaque Creek near Washingtonville	9.5	1961	1977	17	100.0	0	0	0	41.8	57.1	.1	1.0
106	01554500	Shamokin Creek near Shamokin	54.2	1940	1992	53	100.0	0	0	0	72.9	.6	9.9	16.5
107	01555000	Penns Creek at Penns Creek	301	1930	2001	72	76.0	24.0	0	0	68.9	28.9	.8	1.4
108	01555500	East Mahantango Creek near Dalmatia	162	1930	2001	72	100.0	0	0	0	53.3	43.3	1.7	1.6
109	01556000	Frankstown Br Juniata River at Williamsburg	291	1917	2001	85	79.1	20.9	0	0	65.3	25.5	8.2	1.0
110	01556500	Little Juniata River at Tipton	93.7	1946	1961	16	94.9	5.1	0	0	78.5	10.6	10.0	.8
111	01557500	Bald Eagle Creek at Tyrone	44.1	1945	2001	57	95.0	5.0	0	0	91.7	6.8	1.4	.1
112	01558000	Little Juniata River at Spruce Creek	220	1939	2001	63	79.5	20.5	0	0	75.6	18.1	5.7	.6
113	01559500	Standing Stone Creek near Huntingdon	128	1930	1957	28	94.9	5.1	0	0	84.2	14.0	.9	.9
114	01559700	Sulphur Springs Creek near Manns Choice	5.3	1962	1977	16	98.3	1.7	0	0	80.6	19.3	0	.1
115	01560000	Dunning Creek At Beldon	172	1940	2001	62	95.7	4.3	0	0	63.4	34.9	1.3	.3
116	01562500	Great Trough Creek near Markleburg	84.6	1930	1956	27	100.0	0	0	0	76.2	19.7	1.2	2.8
117	01564500	Aughwick Creek near Three Springs	205	1939	2001	63	95.5	4.5	0	0	74.9	22.8	1.4	.9
118	01565000	Kishacoquillas Creek at Reedsville	164	1940	1969	30	75.2	24.8	0	0	62.8	35.2	1.7	.2
119	01565700	Little Lost Creek at Oakland Mills	6.5	1964	1980	17	52.2	47.8	0	0	29.6	68.0	1.8	.7
120	01566000	Tuscarora Creek near Port Royal	214	1912	1957	46	89.1	10.9	0	0	73.8	24.6	.3	1.4
121	01566500	Cocolamus Creek near Millerstown	57.2	1931	1957	27	94.3	5.7	0	0	62.9	36.0	.2	.8
122	01567500	Bixler Run near Loysville	15	1955	2001	47	77.8	22.2	0	0	48.0	50.8	.2	1.0
123	01568000	Sherman Creek at Shermans Dale	207	1930	2001	72	88.6	11.4	0	0	68.6	29.6	.6	1.3
124	01569000	Stony Creek near Dauphin	33.2	1938/68	1944/73	13	100.0	0	0	0	96.1	2.4	.4	1.1
125	01570000	Conodoguinet Creek near Hogestown	470	1930/57	1968/01	62	59.0	38.1	2.9	0	32.9	61.5	4.2	1.3
126	01571000	Paxton Creek near Penbrook	11.2	1941/85/92	1949/87/94	15	87.8	12.1	0	0	32.6	29.1	37.9	.3
127	01571500	Yellow Breeches Creek near Camp Hill	216	1910/55	1919/2001	57	20.5	34.2	45.4	0	54.7	36.8	6.7	1.8

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				Start	End	Number of years	Siliciclastic	Carbonate	Crystalline	Unconsolidated	Forest	Agriculture	Developed	Other
128	01572000	Lower Little Swatara Creek at Pine Grove	34.3	1920	1931	12	100.0	0	0	0	58.9	39.6	0.8	0.7
129	01572025	Swatara Creek near Pine Grove	116	1992	2001	10	100.0	0	0	0	69.0	24.3	3.0	3.7
130	01573000	Swatara Creek at Harper Tavern	337	1919	2001	83	97.6	1.3	1.0	0	52.8	41.3	3.3	2.7
131	01573086	Beck Creek near Cleona	7.9	1964	1980	17	7.5	82.4	10.2	0	16.4	78.9	4.5	.3
132	01573160	Quittapahilla Creek near Bellegrove	74.2	1976	1993	18	19.8	75.5	4.7	0	16.2	65.1	16.4	2.3
133	01573500	Manada Creek at Manada Gap	13.5	1938	1957	20	100.0	0	0	0	88.7	10.2	.8	.3
134	01573560	Swatara Creek near Hershey	483	1976	2001	26	85.6	12.9	1.4	0	45.4	46.8	5.3	2.4
135	01574000	West Conewago Creek near Manchester	510	1929	2001	73	64.1	6.2	29.8	0	30.1	64.1	3.6	2.3
136	01576085	Little Conestoga Creek near Churchtown	5.8	1983	1994	12	49.0	51.0	0	0	28.5	70.0	1.3	.1
137	01576754	Conestoga River at Conestoga	470	1985	2001	17	33.2	59.0	7.8	0	23.7	62.7	11.9	1.6
138	01603500	Evitts Creek near Centerville	30.2	1933	1981	49	78.2	21.8	0	0	79.0	20.2	.5	.2
139	01613050	Tonoloway Creek near Needmore	10.7	1966/74	1972/2001	35	100.0	0	0	0	71.0	28.9	0	.1
140	01613500	Licking Creek near Sylvan	158	1931	1940	10	83.8	16.2	0	0	65.7	32.4	1.2	.8
141	01614090	Conococheague Creek near Fayetteville	5.1	1961	1980	20	0	0	100.0	0	98.8	0	.6	.6
142	03007800	Allegheny River at Port Allegany	248	1975	2001	27	100.0	0	0	0	87.5	11.0	1.4	0
143	03008000	Newell Creek near Port Allegany	7.8	1966	1977	12	100.0	0	0	0	81.6	18.3	.1	0
144	03009680	Potato Creek at Smethport	160	1975	1990	16	100.0	0	0	0	92.2	5.8	1.6	.5
145	03010655	Oswayo Creek at Shinglehouse	98.7	1975/97	1994/01	25	100.0	0	0	0	85.5	14.1	.4	0
146	03011800	Kinzua Creek near Guffey	38.8	1966	2001	36	100.0	0	0	0	95.5	1.7	2.1	.6
147	03015280	Jackson Run near North Warren	12.8	1963	1977	15	100.0	0	0	0	69.3	27.5	.9	2.3
148	03015500	Brokenstraw Creek at Youngsville	321	1910	2001	92	100.0	0	0	0	69.5	26.5	1.3	2.6
149	03017500	Tionesta Creek at Lynch	233	1939	1978	40	100.0	0	0	0	95.8	2.1	2.0	.1
150	03019000	Tionesta Creek at Nebraska	469	1924	1939	16	100.0	0	0	0	96.1	2.2	1.5	.2
151	03020500	Oil Creek at Rouseville	300	1933	2001	69	100.0	0	0	0	74.9	22.4	1.4	1.2
152	03021000	Oil Creek near Rouseville	315	1910	1931	22	100.0	0	0	0	76.1	21.1	1.6	1.1
153	03021350	French Creek near Wattsburg	92	1975	2001	27	100.0	0	0	0	53.7	43.4	1.0	1.8
154	03021410	West Branch French Creek near Lowville	52.3	1975	1992	18	100.0	0	0	0	58.9	34.5	1.3	5.2

Table 1. Streamflow-gaging stations used to estimate ground-water recharge in Pennsylvania, with generalized rock types and land-use classes for watershed.

Map identification number (fig. 1)	Station identification number	Station name	Drainage area (square miles)	Period of record used			Rock type[1] (percent of basin)				Land-use classes[2] (percent of basin)			
				Start	End	Number of years	Siliciclastic	Carbonate	Crystalline	Unconsolidated	Forest	Agriculture	Developed	Other
155	03021500	French Creek at Carters Corners	208	1910	1970	61	100.0	0	0	0	56.0	39.5	1.1	3.4
156	03021700	Little Conneauttee Creek near McKean	3.6	1961	1977	17	100.0	0	0	0	60.4	39.4	.1	.1
157	03022540	Woodcock Creek at Blooming Valley	31.1	1975	1994	20	100.0	0	0	0	61.4	36.7	.2	1.6
158	03023000	Cussewago Creek near Meadville	90.2	1911	1937	27	100.0	0	0	0	49.7	40.4	2.1	7.9
159	03025000	Sugar Creek at Sugarcreek	166	1933	1978	46	100.0	0	0	0	70.7	27.4	.4	1.6
160	03025200	Patchel Run near Franklin	5.7	1965	1977	13	100.0	0	0	0	77.8	20.8	.8	.5
161	03026500	Sevenmile Run near Rasselas	7.8	1952	2001	50	100.0	0	0	0	93.9	2.0	.3	3.8
162	03028000	West Branch Clarion River at Wilcox	63	1954	2001	48	100.0	0	0	0	90.4	7.5	1.8	.3
163	03029400	Toms Run at Cooksburg	12.6	1960	1977	18	100.0	0	0	0	93.3	5.3	1.1	.3
164	03031950	Big Run near Sprankle Mills	7.4	1964	1980	17	100.0	0	0	0	53.6	41.1	.5	4.8
165	03034000	Mahoning Creek at Punxsutawney	158	1939	2001	63	100.0	0	0	0	70.4	24.0	3.1	2.5
166	03034500	Little Mahoning Creek at McCormick	87.4	1940	2001	62	100.0	0	0	0	73.2	26.0	.4	.4
167	03035000	Mahoning Creek near Dayton	321	1921	1939	19	100.0	0	0	0	70.2	26.4	1.8	1.6
168	03038000	Crooked Creek at Idaho	191	1938	2001	64	100.0	0	0	0	68.0	29.3	1.2	1.5
169	03039200	Clear Run near Buckstown	3.7	1965	1977	13	100.0	0	0	0	79.0	.3	.3	20.4
170	03039925	North Fork Bens Creek at North Fork Reservoir	3.5	1988	1997	10	100.0	0	0	0	99.9	.1	0	0
171	03042000	Blacklick Creek at Josephine	192	1953	2001	49	100.0	0	0	0	77.0	18.0	2.0	3.0
172	03042200	Little Yellow Creek near Strongstown	7.4	1961	1977	17	100.0	0	0	0	88.2	9.2	.2	2.4
173	03042500	Two Lick Creek at Graceton	171	1952	1968	17	100.0	0	0	0	71.5	20.2	5.4	2.9
174	03045500	Loyalhanna Creek at New Alexandria		1920/26	1922/39	17	100.0	0	0	0	69.3	24.8	5.1	.8
175	03049000	Buffalo Creek near Freeport	137	1941	2001	61	100.0	0	0	0	66.7	30.4	1.8	1.1
176	03049800	Little Pine Creek near Etna	5.8	1963	2001	39	98.4	0	0	1.6	63.7	8.0	28.1	.2
177	03072000	Dunkard Creek at Shannopin	229	1941	2001	61	100.0	0	0	0	78.2	20.3	.7	.8
178	03072590	Georges Creek at Smithfield	16.3	1964	1977	14	100.0	0	0	0	56.3	30.9	9.6	3.2
179	03072840	Tenmile Creek near Clarksville	133	1969	1978	10	100.0	0	0	0	54.7	41.8	3.3	.2

Table 1. Streamflow-gaging stations used to estimate ground-water recharge in Pennsylvania, with generalized rock types and land-use classes for watershed.

Map identification number (fig. 1)	Station identification number	Station name	Drainage area (square miles)	Period of record used			Rock type[1] (percent of basin)				Land-use classes[2] (percent of basin)			
				Start	End	Number of years	Siliciclastic	Carbonate	Crystalline	Unconsolidated	Forest	Agriculture	Developed	Other
180	03074300	Lick Run at Hopwood	3.8	1967	1977	11	100.0	0	0	0	96.7	1.7	1.2	0.4
181	03074500	Redstone Creek at Waltersburg	73.7	1943	2001	59	100.0	0	0	0	55.3	29.7	13.8	1.2
182	03079000	Casselman River at Markleton	382	1921	2001	81	100.0	0	0	0	60.8	34.2	2.2	2.8
183	03080000	Laurel Hill Creek at Ursina	121	1919	2001	83	100.0	0	0	0	80.4	17.6	1.1	.9
184	03082200	Poplar Run near Normalville	9.3	1962	1977	16	100.0	0	0	0	78.6	14.9	3.8	2.7
185	03084000	Abers Creek near Murrysville	4.4	1949	1992	44	100.0	0	0	0	44.1	10.5	45.5	0
186	03084500	Turtle Creek at Trafford	55.9	1921	1951	31	100.0	0	0	0	60.1	15.7	23.1	1.1
187	03086100	Big Sewickley Creek near Ambridge	15.6	1968	1977	10	100.0	0	0	0	75.8	10.4	13.8	0
188	03100000	Shenango River near Turnersville	152	1913	1921	9	100.0	0	0	0	35.6	34.2	5.7	24.5
189	03101000	Sugar Run at Pymatuning Dam	8.6	1935	1954	20	100.0	0	0	0	41.0	57.3	1.6	.1
190	03102000	Shenango River near Jamestown	181	1920	1933	14	100.0	0	0	0	37.8	36.0	5.2	21.1
191	03102500	Little Shenango River at Greenville	104	1926	2001	76	100.0	0	0	0	44.4	46.0	2.5	7.1
192	03103000	Pymatuning Creek near Orangeville	169	1926	1962	37	100.0	0	0	0	34.6	53.1	.6	11.7
193	03104760	Harthegig Run near Greenfield	2.3	1969	1980	12	100.0	0	0	0	26.0	67.8	2.2	3.9
194	03106000	Connoquenessing Creek near Zelienople	356	1920	2001	82	100.0	0	0	0	52.6	36.4	10.2	.7
195	03106500	Slippery Rock Creek at Wurtemburg	398	1912	1968	57	100.0	0	0	0	54.5	38.2	2.6	4.8
196	03108000	Raccoon Creek at Moffatts Mill	178	1942	1956	15	100.0	0	0	0	64.1	24.5	8.9	2.4
197	03111150	Brush Run near Buffalo	10.3	1961	1977	17	100.0	0	0	0	27.4	71.5	1.1	0

[1]Rock type was assigned from descriptions of geologic formations in Berg and others (1980).

[2]Land cover was assigned from categories in National Land Cover Database 1992 (Vogelmann and others, 2001).

Table 2. Estimates of mean-annual recharge computed by the use of PART and RORA programs, streamflow, and recession index, for the period of record used at 197 streamflow-gaging stations in Pennsylvania.

Map identification number (fig. 1)	Station identification number	Station name	Estimated recharge, in inches		Streamflow, in inches	Recession index (K), in days
			RORA	PART		
1	01429000	West Branch Lackawaxen River at Prompton	20.1	17.4	26.5	40.4
2	01429500	Dyberry Creek near Honesdale	16.8	14.3	24.2	40.8
3	01430000	Lackawaxen River near Honesdale	19.7	16.0	25.6	37.2
4	01430500	Lackawaxen River at West Hawley	18.3	14.7	23.4	27.3
5	01431500	Lackawaxen River at Hawley	16.7	14.1	23.2	33.3
6	01432000	Wallenpaupack Creek at Wilsonville	21.5	18.0	23.6	25.2
7	01439500	Bush Kill At Shoemakers	25.2	21.9	27.2	43.0
8	01440400	Brodhead Creek near Analomink	24.2	20.9	27.6	40.8
9	01441000	McMichael Creek near Stroudsburg	22.2	19.2	24.8	41.9
10	01442500	Brodhead Creek near Minisink	25.2	21.4	29.1	42.2
11	01446600	Martins Creek near East Bangor	14.9	12.0	21.8	28.5
12	01447500	Lehigh River at Stoddartsville	24.0	21.0	27.8	44.4
13	01447720	Tobyhanna Creek near Blakeslee	25.0	22.1	30.5	56.9
14	01448500	Dilldown Creek near Long Pond	22.6	21.1	27.6	67.9
15	01449360	Pohopoco Creek at Kresgeville	26.2	23.2	27.6	50.7
16	01449500	Wild Creek at Hatchery	29.3	26.6	29.9	60.6
17	01450500	Aquashicola Creek at Palmerton	24.1	20.7	26.7	40.2
18	01451500	Little Lehigh Creek near Allentown	15.5	14.2	16.8	121.8
19	01451800	Jordan Creek near Schecksville	19.1	15.1	23.7	32.4
20	01452000	Jordan Creek at Allentown	16.6	13.2	20.6	30.5
21	01452500	Monocacy Creek at Bethlehem	15.5	14.1	16.4	81.0
22	01459500	Tohickon Creek near Pipersville	9.4	6.7	19.5	26.6
23	01460000	Tohickon Creek at Point Pleasant	9.8	7.4	25.5	24.8
24	01465000	Neshaminy Creek at Rushland	12.0	9.8	23.8	28.5
25	01465500	Neshaminy Creek near Langhorne	11.5	9.5	19.3	40.2
26	01465798	Poquessing Creek at Grant Avenue	7.9	7.0	20.7	72.5
27	01467042	Pennypack Creek at Pine Road	16.8	15.0	24.7	65.6
28	01467048	Pennypack Creek at Lower Rhawn Street Bridge	14.5	13.1	24.9	73.5
29	01467050	Wooden Bridge Run at Philadelphia	8.4	7.7	24.2	39.5
30	01467086	Tacony Creek above Adams Avenue	13.8	12.4	22.3	73.0
31	01467087	Frankford Creek at Castor Avenue	7.7	6.6	18.5	39.2
32	01467089	Frankford Creek at Torresdale Avenue	9.9	8.6	23.7	52.4
33	01467500	Schuylkill River at Pottsville	24.3	20.6	25.1	31.9
34	01468500	Schuylkill River at Landingville	26.7	22.9	28.2	39.5
35	01469500	Little Schuylkill River at Tamaqua	24.6	20.6	26.9	33.4
36	01470500	Schuylkill River at Berne	24.2	19.9	27.2	35.1
37	01470720	Maiden Creek Tributary at Lenhartsvile	19.8	14.6	23.0	24.9
38	01470756	Maiden Creek at Virginville	17.9	14.7	22.7	38.3
39	01470779	Tulpehocken Creek near Bernville	20.4	18.4	21.9	80.7
40	01470960	Tulpehocken Creek at Blue Marsh Damsite	19.3	16.4	22.1	46.3

Table 2. Estimates of mean-annual recharge computed by the use of PART and RORA programs, streamflow, and recession index, for the period of record used at 197 streamflow-gaging stations in Pennsylvania.

Map identification number (fig. 1)	Station identification number	Station name	Estimated recharge, in inches		Streamflow, in inches	Recession index (K), in days
			RORA	PART		
41	01471000	Tulpehocken Creek near Reading	17.8	15.4	20.0	55.1
42	01471980	Manatawny Creek near Pottstown	15.7	13.9	20.5	59.2
43	01472157	French Creek near Phoenixville	15.0	13.7	20.3	76.2
44	01472198	Perkiomen Creek at East Greenville	15.9	14.4	21.7	59.4
45	01472199	West Branch Perkiomen Creek at Hillegass	16.3	14.5	22.1	51.0
46	01472500	Perkiomen Creek near Frederick	12.2	9.9	22.7	26.6
47	01473000	Perkiomen Creek at Graterford	10.4	8.4	19.0	34.7
48	01473169	Valley Creek at PA Turnpike Br near Valley Forge	17.3	15.8	20.9	116.0
49	01474000	Wissahickon Creek at Mouth Philadelphia	14.8	12.7	22.2	25.8
50	01475300	Darby Creek at Waterloo Mills near Devon	16.7	15.5	23.3	78.6
51	01475510	Darby Creek near Darby	16.8	15.2	23.6	85.7
52	01475850	Crum Creek near Newtown Square	14.0	12.9	19.6	78.2
53	01476500	Ridley Creek at Moylan	14.9	13.4	18.8	73.3
54	01477000	Chester Creek near Chester	14.8	13.5	20.2	87.4
55	01479820	Red Clay Creek near Kennett Square	13.9	12.6	18.3	76.1
56	01480300	West Branch Brandywine Creek near Honey Brook	12.2	11.1	19.1	79.8
57	01480675	Marsh Creek near Glenmoore	13.4	11.9	19.9	48.5
58	01480800	East Branch Brandywine Creek at Downingtown	10.5	9.3	14.2	56.9
59	01481000	Brandywine Creek at Chadds Ford	15.0	13.2	18.9	72.2
60	01516350	Tioga River near Mansfield	13.7	11.4	18.9	45.4
61	01516500	Corey Creek near Mainesburg	10.4	8.0	13.9	26.9
62	01517000	Elk Run near Mainesburg	10.7	7.7	14.4	21.7
63	01518000	Tioga River at Tioga	10.9	9.0	16.1	30.7
64	01518500	Crooked Creek at Tioga	9.0	6.9	12.5	24.2
65	01518862	Cowanesque River at Westfield	12.5	9.3	15.5	23.2
66	01520000	Cowanesque River near Lawrenceville	8.8	6.7	13.5	26.9
67	01532000	Towanda Creek near Monroeton	12.5	9.7	18.2	34.6
68	01532850	Main Branch Wyalusing Creek near Birchardville	17.9	13.2	22.9	26.0
69	01533500	North Branch Mehoopany Creek near Lovelton	12.9	10.7	17.9	33.6
70	01533950	South Branch Tunkhannock Creek near Montdale	14.0	10.6	18.6	24.9
71	01534000	Tunkhannock Creek near Tunkhannock	13.9	11.2	19.2	30.8
72	01534500	Lackawanna River at Archbald	21.8	18.8	25.8	38.7
73	01535500	Lackawanna River at Moosic	20.6	17.8	24.6	30.2
74	01536000	Lackawanna River at Old Forge	19.7	16.7	23.2	34.0
75	01537500	Solomon Creek at Wilkes-Barre	14.5	11.6	16.1	23.3
76	01538000	Wapwallopen Creek near Wapwallopen	17.7	14.8	20.1	25.2
77	01539000	Fishing Creek near Bloomsburg	19.2	15.6	23.6	31.3
78	01539500	Little Fishing Creek at Eyers Grove	14.9	11.1	20.3	23.3
79	01540000	Fishing Creek at Bloomsburg	19.8	15.9	26.6	24.4
80	01540200	Trexler Run near Ringtown	16.4	14.1	17.3	31.6
81	01541000	West Branch Susquehanna River at Bower	17.5	13.9	23.9	26.4

Table 2. Estimates of mean-annual recharge computed by the use of PART and RORA programs, streamflow, and recession index, for the period of record used at 197 streamflow-gaging stations in Pennsylvania.

Map identification number (fig. 1)	Station identification number	Station name	Estimated recharge, in inches		Streamflow, in inches	Recession index (K), in days
			RORA	PART		
82	01541200	West Branch Susquehanna River near Curwensville	16.1	13.3	21.8	33.6
83	01541308	Bradley Run near Ashville	22.8	20.1	26.1	41.6
84	01541500	Clearfield Creek at Dimeling	16.5	13.2	21.2	30.3
85	01542000	Moshannon Creek at Osceola Mills	19.9	17.2	21.8	38.1
86	01542810	Waldy Run near Emporium	16.2	12.4	22.4	29.9
87	01543000	Driftwood Br Sinnemahoning Creek at Sterling Run	16.3	12.7	22.4	27.9
88	01544500	Kettle Creek At Cross Fork	19.2	15.1	22.6	27.8
89	01545600	Young Womans Creek near Renovo	19.1	16.2	21.5	30.6
90	01546000	North Bald Eagle Creek at Milesburg	15.5	11.0	23.8	20.2
91	01546400	Spring Creek at Houserville	14.7	13.3	15.2	67.0
92	01546500	Spring Creek near Axemann	14.6	13.1	14.6	78.7
93	01547100	Spring Creek at Milesburg	18.2	16.3	17.9	85.3
94	01547200	Bald Eagle Creek below Spring Creek at Milesburg	17.6	15.6	20.7	58.6
95	01547500	Bald Eagle Creek at Blanchard	13.3	12.0	15.9	56.6
96	01547700	Marsh Creek at Blanchard	14.6	11.8	18.0	28.1
97	01547800	South Fork Beech Creek near Snow Shoe	24.9	21.2	26.5	37.3
98	01547950	Beech Creek at Monument	21.9	18.4	23.5	33.0
99	01549500	Blockhouse Creek near English Center	16.8	13.6	21.0	29.0
100	01549780	Larrys Creek at Cogan House	18.1	14.5	21.3	28.9
101	01550000	Lycoming Creek near Trout Run	18.7	14.7	22.5	28.5
102	01552000	Loyalsock Creek at Loyalsockville	18.2	14.4	23.7	30.4
103	01552500	Muncy Creek near Sonestown	22.2	17.7	27.3	31.4
104	01553130	Sand Spring Run near White Deer	23.6	21.1	24.8	43.6
105	01553600	East Branch Chillisquaque Creek near Washington-ville	12.0	8.1	17.5	20.6
106	01554500	Shamokin Creek near Shamokin	21.0	18.8	21.3	71.7
107	01555000	Penns Creek at Penns Creek	17.7	14.9	19.8	36.1
108	01555500	East Mahantango Creek near Dalmatia	15.6	12.3	18.9	32.2
109	01556000	Frankstown Br Juniata River at Williamsburg	14.4	12.1	18.5	36.5
110	01556500	Little Juniata River at Tipton	19.0	15.4	21.5	27.0
111	01557500	Bald Eagle Creek at Tyrone	19.3	16.4	23.1	33.2
112	01558000	Little Juniata River at Spruce Creek	20.7	17.2	23.1	37.1
113	01559500	Standing Stone Creek near Huntingdon	12.5	10.4	15.6	30.4
114	01559700	Sulphur Springs Creek near Manns Choice	12.5	9.4	14.1	22.9
115	01560000	Dunning Creek At Beldon	13.7	10.5	18.3	31.8
116	01562500	Great Trough Creek near Marklesburg	12.7	9.9	15.3	27.7
117	01564500	Aughwick Creek near Three Springs	12.1	9.0	16.3	31.3
118	01565000	Kishacoquillas Creek at Reedsville	16.1	13.7	16.9	39.9
119	01565700	Little Lost Creek at Oakland Mills	12.6	10.7	15.9	37.7
120	01566000	Tuscarora Creek near Port Royal	12.1	9.3	16.4	29.6
121	01566500	Cocolamus Creek near Millerstown	14.2	11.0	18.4	26.4

Table 2. Estimates of mean-annual recharge computed by the use of PART and RORA programs, streamflow, and recession index, for the period of record used at 197 streamflow-gaging stations in Pennsylvania.

Map identification number (fig. 1)	Station identification number	Station name	Estimated recharge, in inches		Streamflow, in inches	Recession index (K), in days
			RORA	PART		
122	01567500	Bixler Run near Loysville	13.9	12.1	17.6	49.7
123	01568000	Sherman Creek at Shermans Dale	14.8	12.0	19.1	35.9
124	01569000	Stony Creek near Dauphin	20.4	17.8	24.0	42.7
125	01570000	Conodoguinet Creek near Hogestown	13.3	11.2	16.9	37.1
126	01571000	Paxton Creek near Penbrook	13.3	10.4	18.3	27.2
127	01571500	Yellow Breeches Creek near Camp Hill	17.2	15.2	18.5	59.9
128	01572000	Lower Little Swatara Creek at Pine Grove	18.0	14.6	22.1	25.2
129	01572025	Swatara Creek near Pine Grove	20.6	17.5	24.5	45.4
130	01573000	Swatara Creek at Harper Tavern	17.8	14.3	23.0	30.3
131	01573086	Beck Creek near Cleona	13.8	12.8	14.9	92.6
132	01573160	Quittapahilla Creek near Bellegrove	18.2	16.3	19.1	73.6
133	01573500	Manada Creek at Manada Gap	20.5	17.0	23.3	35.4
134	01573560	Swatara Creek near Hershey	17.3	14.0	21.8	28.6
135	01574000	West Conewago Creek near Manchester	9.5	7.7	16.0	32.4
136	01576085	Little Conestoga Creek near Churchtown	12.6	11.2	17.7	45.5
137	01576754	Conestoga River at Conestoga	15.4	13.1	18.4	55.3
138	01603500	Evitts Creek near Centerville	12.1	10.0	14.5	37.1
139	01613050	Tonoloway Creek near Needmore	13.1	9.9	16.5	36.2
140	01613500	Licking Creek near Sylvan	11.1	8.1	14.8	25.2
141	01614090	Conococheague Creek near Fayetteville	18.5	16.5	19.8	43.4
142	03007800	Allegheny River at Port Allegany	20.3	16.3	24.4	30.8
143	03008000	Newell Creek near Port Allegany	18.2	12.8	21.6	19.3
144	03009680	Potato Creek at Smethport	22.1	17.6	26.2	34.1
145	03010655	Oswayo Creek at Shinglehouse	18.4	14.9	20.8	29.8
146	03011800	Kinzua Creek near Guffey	22.6	19.7	27.0	38.5
147	03015280	Jackson Run near North Warren	19.8	15.8	25.4	30.4
148	03015500	Brokenstraw Creek at Youngsville	16.1	13.6	25.0	36.8
149	03017500	Tionesta Creek at Lynch	21.3	16.8	25.0	28.3
150	03019000	Tionesta Creek at Nebraska	18.7	14.6	24.0	31.0
151	03020500	Oil Creek at Rouseville	15.9	13.6	24.3	42.1
152	03021000	Oil Creek near Rouseville	15.0	11.8	22.4	29.5
153	03021350	French Creek near Wattsburg	18.9	15.1	32.1	28.6
154	03021410	West Branch French Creek near Lowville	18.7	15.8	34.2	37.2
155	03021500	French Creek at Carters Corners	16.6	13.7	27.2	40.8
156	03021700	Little Conneauttee Creek near McKean	13.9	11.6	28.8	35.4
157	03022540	Woodcock Creek at Blooming Valley	16.6	13.6	24.3	36.2
158	03023000	Cussewago Creek near Meadville	12.8	9.2	19.4	22.7
159	03025000	Sugar Creek at Sugarcreek	17.6	14.1	22.2	30.9
160	03025200	Patchel Run near Franklin	19.7	17.0	21.3	33.1
161	03026500	Sevenmile Run near Rasselas	21.7	17.8	25.0	28.5
162	03028000	West Branch Clarion River at Wilcox	23.7	19.3	27.0	31.9

Table 2. Estimates of mean-annual recharge computed by the use of PART and RORA programs, streamflow, and recession index, for the period of record used at 197 streamflow-gaging stations in Pennsylvania.

Map identification number (fig. 1)	Station identification number	Station name	Estimated recharge, in inches		Streamflow, in inches	Recession index (K), in days
			RORA	PART		
163	03029400	Toms Run at Cooksburg	19.0	15.1	21.0	23.7
164	03031950	Big Run near Sprankle Mills	19.2	15.2	24.7	23.8
165	03034000	Mahoning Creek at Punxsutawney	19.4	15.6	23.8	32.8
166	03034500	Little Mahoning Creek at McCormick	16.9	13.0	23.4	29.2
167	03035000	Mahoning Creek near Dayton	17.8	13.5	23.7	21.4
168	03038000	Crooked Creek at Idaho	15.2	10.4	20.3	22.4
169	03039200	Clear Run near Buckstown	18.9	15.8	22.8	28.6
170	03039925	North Fork Bens Creek at North Fork Reservoir	27.7	23.6	30.8	29.1
171	03042000	Blacklick Creek at Josephine	20.3	16.3	25.8	33.5
172	03042200	Little Yellow Creek near Strongstown	20.5	15.3	24.9	21.0
173	03042500	Two Lick Creek at Graceton	15.5	12.2	20.5	33.1
174	03045500	Loyalhanna Creek at New Alexandria	15.2	12.2	22.2	21.1
175	03049000	Buffalo Creek near Freeport	14.5	10.9	18.8	30.2
176	03049800	Little Pine Creek near Etna	11.1	8.3	14.4	27.3
177	03072000	Dunkard Creek at Shannopin	10.5	7.0	16.3	22.1
178	03072590	Georges Creek at Smithfield	12.7	9.6	16.0	25.8
179	03072840	Tenmile Creek near Clarksville	11.1	8.3	15.3	27.6
180	03074300	Lick Run at Hopwood	20.9	15.3	25.0	21.3
181	03074500	Redstone Creek at Waltersburg	15.1	12.7	18.7	35.4
182	03079000	Casselman River at Markleton	16.7	13.3	23.5	29.9
183	03080000	Laurel Hill Creek at Ursina	22.9	17.6	29.8	26.5
184	03082200	Poplar Run near Normalville	21.3	15.3	28.0	21.7
185	03084000	Abers Creek near Murrysville	11.8	9.3	16.7	25.0
186	03084500	Turtle Creek at Trafford	13.1	9.9	18.6	20.2
187	03086100	Big Sewickley Creek near Ambridge	12.5	9.0	15.0	20.5
188	03100000	Shenango River near Turnersville	13.7	10.1	17.9	18.5
189	03101000	Sugar Run at Pymatuning Dam	7.8	5.8	16.3	23.9
190	03102000	Shenango River near Jamestown	13.9	10.2	16.4	20.5
191	03102500	Little Shenango River at Greenville	11.8	9.7	18.6	35.2
192	03103000	Pymatuning Creek near Orangeville	13.4	8.2	16.3	19.3
193	03104760	Harthegig Run near Greenfield	9.9	7.2	19.2	22.6
194	03106000	Connoquenessing Creek near Zelienople	12.4	9.5	17.5	25.5
195	03106500	Slippery Rock Creek at Wurtemburg	11.8	9.8	18.7	35.4
196	03108000	Raccoon Creek at Moffatts Mill	11.5	9.2	15.8	35.2
197	03111150	Brush Run near Buffalo	9.2	7.4	12.3	35.4

Table 3. Estimates of mean-monthly recharge as a percentage of mean-annual recharge computed by the use of RORA for the period of record used at 197 streamflow-gaging stations in Pennsylvania.

Map identification number (fig. 1)	Station identification number	Station name	Mean-monthly recharge, as a percentage of mean-annual recharge											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	01429000	West Branch Lackawaxen River at Prompton	9.7	8.8	19.1	16.4	8.7	2.1	3.8	2.2	4.1	5.2	9.9	10.0
2	01429500	Dyberry Creek near Honesdale	9.5	7.7	22.1	16.9	9.8	1.3	3.9	1.5	2.6	5.2	10.2	9.3
3	01430000	Lackawaxen River near Honesdale	10.4	10.0	19.0	18.6	6.2	1.5	2.5	2.3	2.5	5.5	10.3	11.1
4	01430500	Lackawaxen River at West Hawley	10.0	7.9	19.9	14.6	8.6	4.1	3.6	3.6	4.5	6.1	8.8	8.3
5	01431500	Lackawaxen River at Hawley	10.2	9.6	19.4	17.9	7.7	3.0	3.7	3.1	2.6	5.4	8.6	8.9
6	01432000	Wallenpaupack Creek at Wilsonville	11.7	9.8	21.0	14.3	9.1	5.5	4.0	2.3	2.1	5.7	6.6	7.8
7	01439500	Bush Kill At Shoemakers	10.1	10.7	18.2	13.1	9.8	4.2	3.4	2.5	3.5	5.4	9.7	9.6
8	01440400	Brodhead Creek near Analomink	10.2	10.7	17.7	13.0	10.3	4.0	2.5	2.0	3.8	5.5	10.3	9.8
9	01441000	McMichael Creek near Stroudsburg	10.8	10.4	18.0	11.6	7.2	4.8	6.0	4.3	4.7	5.3	8.5	8.4
10	01442500	Brodhead Creek near Minisink	10.2	10.5	15.7	13.6	9.6	3.8	3.3	2.6	4.0	5.5	10.3	10.8
11	01446600	Martins Creek near East Bangor	9.6	11.7	19.6	12.1	8.5	4.4	1.3	2.1	3.4	5.4	9.8	12.3
12	01447500	Lehigh River at Stoddartsville	9.2	9.2	16.5	14.0	9.9	4.6	3.7	2.8	4.4	5.8	10.4	9.5
13	01447720	Tobyhanna Creek near Blakeslee	8.4	9.6	19.2	10.8	8.4	5.2	3.4	2.2	5.9	7.8	8.8	10.2
14	01448500	Dilldown Creek near Long Pond	8.5	8.8	19.1	12.2	9.9	3.3	3.0	2.8	4.1	6.7	11.4	10.3
15	01449360	Pohopoco Creek at Kresgeville	10.0	9.4	14.8	11.0	10.4	6.0	3.8	4.1	4.5	5.8	9.9	10.3
16	01449500	Wild Creek at Hatchery	8.0	8.3	15.6	13.7	13.1	3.1	6.3	3.7	3.8	5.0	9.0	10.5
17	01450500	Aquashicola Creek at Palmerton	9.1	9.8	15.3	11.2	9.7	4.7	5.0	4.2	5.2	5.7	9.7	10.3
18	01451500	Little Lehigh Creek near Allentown	10.1	10.2	14.9	11.2	8.1	5.4	5.9	5.4	5.6	5.9	7.7	9.6
19	01451800	Jordan Creek near Schecksville	11.2	10.5	17.1	9.7	9.3	4.5	3.1	2.7	4.8	5.9	10.3	11.0
20	01452000	Jordan Creek at Allentown	10.5	11.1	17.7	10.7	9.2	3.9	3.6	3.5	4.5	5.1	9.8	10.4
21	01452500	Monocacy Creek at Bethlehem	8.9	9.8	14.4	10.0	9.3	6.3	5.8	6.2	6.0	6.2	8.9	8.3
22	01459500	Tohickon Creek near Pipersville	10.3	15.3	18.5	11.9	6.7	4.8	1.6	2.5	1.7	2.7	10.3	13.7
23	01460000	Tohickon Creek at Point Pleasant	14.9	16.2	20.8	8.2	7.4	1.9	2.1	3.0	3.1	4.5	7.9	10.3
24	01465000	Neshaminy Creek at Rushland	14.2	13.0	18.9	10.5	6.6	2.7	2.7	3.5	2.6	6.0	8.4	11.2
25	01465500	Neshaminy Creek near Langhorne	11.8	14.1	16.5	11.8	7.7	4.1	4.3	3.3	3.6	4.2	8.1	10.7
26	01465798	Poquessing Creek at Grant Ave	10.9	11.8	13.8	11.0	8.5	5.2	7.6	3.2	5.2	4.8	8.0	10.0
27	01467042	Pennypack Creek at Pine Road	11.2	10.5	14.6	10.3	8.3	6.1	5.8	4.8	6.3	5.7	7.0	9.6
28	01467048	Pennypack Creek at Lower Rhawn Street Bridge	10.7	10.2	15.3	11.3	8.5	5.0	5.6	4.2	5.6	5.4	8.2	10.0

Table 3. Estimates of mean-monthly recharge as a percentage of mean-annual recharge computed by the use of RORA for the period of record used at 197 streamflow-gaging stations in Pennsylvania.

Map identification number (fig. 1)	Station identification number	Station name	Mean-monthly recharge, as a percentage of mean-annual recharge											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
29	01467050	Wooden Bridge Run at Philadelphia	8.9	10.0	12.1	10.9	8.2	8.1	8.9	4.6	6.4	3.9	9.1	9.2
30	01467086	Tacony Creek above Adams Avenue	9.7	9.8	14.1	11.7	8.1	5.8	6.9	4.5	5.5	6.4	7.7	9.8
31	01467087	Frankford Creek at Castor Avenue	8.5	10.7	14.2	12.0	10.2	7.5	7.1	4.8	5.4	5.0	6.7	7.9
32	01467089	Frankford Creek at Torresdale Avenue	9.1	8.3	12.8	10.4	9.4	6.7	10.0	3.5	6.8	6.1	7.0	9.9
33	01467500	Schuylkill River at Pottsville	8.7	8.7	16.0	11.5	12.2	4.7	6.6	4.3	4.9	4.5	8.5	9.4
34	01468500	Schuylkill River at Landingville	10.1	9.6	14.4	11.5	10.6	6.4	4.4	3.6	5.1	6.5	8.7	9.1
35	01469500	Little Schuylkill River at Tamaqua	8.9	9.9	15.8	12.7	10.4	5.7	3.9	3.2	4.6	5.4	9.5	10.0
36	01470500	Schuylkill River at Berne	9.7	11.0	14.4	12.6	9.9	5.0	3.6	3.8	4.2	5.7	9.5	10.6
37	01470720	Maiden Creek Tributary at Lenhartsvile	11.1	9.3	14.6	10.4	7.9	6.7	3.7	3.6	5.4	6.4	9.1	11.7
38	01470756	Maiden Creek at Virginville	10.5	10.2	17.7	10.1	10.4	3.8	3.8	2.8	4.8	5.3	10.1	10.2
39	01470779	Tulpehocken Creek near Bernville	11.5	9.7	16.5	8.2	7.5	6.4	6.1	3.8	5.9	6.7	8.9	8.8
40	01470960	Tulpehocken Creek at Blue Marsh Dam-site	10.1	9.1	15.8	7.8	9.1	7.2	5.6	4.0	5.2	5.9	7.9	12.2
41	01471000	Tulpehocken Creek near Reading	11.3	10.6	16.0	10.5	7.8	5.3	4.8	3.9	5.5	5.6	8.3	10.4
42	01471980	Manatawny Creek near Pottstown	12.4	10.9	16.4	11.0	8.3	4.6	4.7	3.3	4.4	5.8	9.2	8.9
43	01472157	French Creek near Phoenixville	12.0	12.7	17.2	11.4	8.0	4.4	3.7	2.7	4.4	5.5	8.2	9.8
44	01472198	Perkiomen Creek at East Greenville	10.4	11.2	19.0	11.3	8.6	4.2	4.1	3.4	4.5	5.2	9.5	8.7
45	01472199	West Branch Perkiomen Creek at Hille-gass	10.2	11.4	18.9	11.1	9.6	3.8	4.2	2.9	4.2	5.2	9.4	9.2
46	01472500	Perkiomen Creek near Frederick	11.2	12.3	19.5	9.9	7.9	3.4	3.8	3.6	4.0	5.7	7.9	10.6
47	01473000	Perkiomen Creek at Graterford	11.0	17.6	15.2	10.3	7.1	3.0	4.9	4.7	3.7	4.8	8.3	9.3
48	01473169	Valley Creek at PA Turnpike Br near Valley Forge	10.8	10.0	15.4	10.9	8.4	4.3	5.9	4.6	5.8	7.0	8.0	8.6
49	01474000	Wissahickon Creek at Mouth Philadel-phia	9.8	9.7	14.0	11.6	9.8	6.6	5.9	5.2	5.1	6.1	7.5	8.7
50	01475300	Darby Creek at Waterloo Mills near Devon	11.7	10.9	15.0	11.6	8.7	5.1	4.4	3.6	5.6	5.8	8.2	9.4
51	01475510	Darby Creek near Darby	9.1	11.4	13.2	11.4	9.5	5.2	6.4	4.0	5.6	6.1	8.0	10.0
52	01475850	Crum Creek near Newtown Square	11.4	11.4	16.7	11.3	7.8	4.6	4.1	3.4	4.7	6.6	8.9	9.1
53	01476500	Ridley Creek at Moylan	10.9	13.5	14.3	12.0	8.2	4.9	4.5	5.0	4.4	5.3	7.9	9.0
54	01477000	Chester Creek near Chester	10.8	12.0	15.6	10.9	7.8	4.3	4.9	4.3	5.7	6.0	8.5	9.1

Table 3. Estimates of mean-monthly recharge as a percentage of mean-annual recharge computed by the use of RORA for the period of record used at 197 streamflow-gaging stations in Pennsylvania.

Map identification number (fig. 1)	Station identification number	Station name	Mean-monthly recharge, as a percentage of mean-annual recharge											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
55	01479820	Red Clay Creek near Kennett Square	11.4	10.6	15.4	9.5	8.7	5.6	4.9	3.7	6.5	6.5	7.9	9.4
56	01480300	West Branch Brandywine Creek near Honey Brook	12.0	11.4	13.9	9.8	7.4	5.6	5.0	3.6	5.3	7.1	10.0	9.0
57	01480675	Marsh Creek near Glenmoore	10.5	12.1	16.8	12.6	8.9	5.3	4.0	3.0	4.3	5.2	8.5	8.8
58	01480800	East Branch Brandywine Creek at Downingtown	10.4	14.3	15.4	15.8	7.6	4.5	4.0	3.5	5.3	4.9	6.7	7.6
59	01481000	Brandywine Creek at Chadds Ford	10.3	11.9	14.2	12.0	8.7	5.6	5.2	4.7	5.2	5.3	7.8	9.0
60	01516350	Tioga River near Mansfield	8.1	10.4	23.9	14.7	6.4	4.0	2.0	2.2	3.4	5.3	11.1	8.6
61	01516500	Corey Creek near Mainesburg	8.9	11.4	22.3	16.3	8.4	4.2	1.3	1.3	2.0	4.4	9.0	10.0
62	01517000	Elk Run near Mainesburg	7.3	10.3	23.5	17.3	9.5	4.0	0.5	1.2	1.4	5.2	8.7	11.2
63	01518000	Tioga River at Tioga	7.0	8.0	23.0	17.0	12.3	3.4	1.8	1.8	2.2	4.8	9.3	9.2
64	01518500	Crooked Creek at Tioga	5.0	8.1	25.0	22.5	10.5	4.0	1.4	1.5	1.2	3.8	7.4	9.7
65	01518862	Cowanesque River at Westfield	8.3	12.4	17.2	20.1	6.4	4.6	2.0	2.8	1.8	4.6	11.1	8.6
66	01520000	Cowanesque River near Lawrenceville	8.2	9.4	23.8	19.3	9.3	3.3	1.4	1.1	2.4	4.2	7.2	10.3
67	01532000	Towanda Creek near Monroeton	8.4	10.0	23.3	14.8	8.8	3.1	2.0	2.0	2.5	5.4	10.2	9.4
68	01532850	Main Branch Wyalusing Creek near Birchardville	9.8	8.9	22.0	8.7	9.1	6.0	1.0	2.1	3.9	6.8	10.1	11.6
69	01533500	North Branch Mehoopany Creek near Lovelton	9.1	10.6	18.9	17.8	10.8	2.1	2.5	1.5	1.4	4.8	9.1	11.5
70	01533950	South Branch Tunkhannock Creek near Montdale	8.8	10.2	19.2	14.1	10.0	5.7	2.4	1.8	3.1	5.9	8.5	10.3
71	01534000	Tunkhannock Creek near Tunkhannock	8.7	10.0	20.0	14.6	8.8	3.8	2.7	2.2	3.3	5.2	10.8	9.7
72	01534500	Lackawanna River at Archbald	7.8	8.1	17.4	15.6	9.8	3.5	5.1	3.0	3.6	5.9	11.0	9.2
73	01535500	Lackawanna River at Moosic	9.5	7.7	16.1	12.7	8.9	6.4	4.8	5.0	4.0	6.5	9.2	9.1
74	01536000	Lackawanna River at Old Forge	7.1	8.7	15.7	17.9	10.5	4.4	5.6	3.4	3.6	5.1	9.1	9.0
75	01537500	Solomon Creek at Wilkes-Barre	7.9	10.2	14.0	12.8	12.0	5.3	4.0	3.5	5.0	6.2	9.5	9.8
76	01538000	Wapwallopen Creek near Wapwallopen	9.0	11.0	17.0	14.1	10.6	4.9	3.7	2.5	3.5	5.0	9.1	9.7
77	01539000	Fishing Creek near Bloomsburg	8.6	10.3	17.4	13.8	9.5	4.0	3.1	2.6	4.1	5.5	10.4	10.7
78	01539500	Little Fishing Creek at Eyers Grove	10.4	12.5	18.2	13.7	10.8	2.6	2.6	1.4	2.4	4.3	8.9	12.1
79	01540000	Fishing Creek at Bloomsburg	9.6	9.5	19.3	11.8	8.5	4.5	4.7	4.5	4.3	6.8	7.5	8.8
80	01540200	Trexler Run near Ringtown	9.4	10.0	18.0	12.0	13.1	5.7	2.2	1.5	4.3	5.9	6.9	11.0

Table 3. Estimates of mean-monthly recharge as a percentage of mean-annual recharge computed by the use of RORA for the period of record used at 197 streamflow-gaging stations in Pennsylvania.

Map identification number (fig. 1)	Station identification number	Station name	Mean-monthly recharge, as a percentage of mean-annual recharge											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
81	01541000	West Branch Susquehanna River at Bower	10.2	11.7	19.6	13.1	9.4	4.4	3.4	2.6	3.0	4.2	8.4	10.1
82	01541200	West Branch Susquehanna River near Curwensville	9.6	11.6	23.4	16.4	8.6	3.0	4.7	3.0	2.2	2.1	6.7	8.8
83	01541308	Bradley Run near Ashville	9.7	9.2	19.5	12.2	9.0	5.0	2.8	2.2	4.3	6.4	7.9	11.7
84	01541500	Clearfield Creek at Dimeling	10.5	11.5	19.3	14.4	9.9	4.7	3.0	2.4	3.1	4.1	7.4	9.4
85	01542000	Moshannon Creek at Osceola Mills	8.3	11.2	19.9	13.6	12.5	5.5	3.1	3.0	2.6	4.2	7.3	8.9
86	01542810	Waldy Run near Emporium	7.7	11.1	19.5	14.0	9.3	4.2	1.7	2.2	3.3	5.1	11.0	11.1
87	01543000	Driftwood Br Sinnemahoning Creek at Sterling Run	9.4	10.4	18.9	15.6	11.0	3.8	2.4	1.8	2.7	4.4	9.8	9.9
88	01544500	Kettle Creek At Cross Fork	8.1	9.9	19.8	16.3	10.6	4.3	2.9	1.8	2.5	4.9	8.9	10.0
89	01545600	Young Womans Creek near Renovo	7.4	10.7	16.5	16.7	10.2	5.0	3.2	1.9	3.1	5.4	9.8	10.0
90	01546000	North Bald Eagle Creek at Milesburg	10.4	11.9	22.9	10.6	11.6	6.1	2.2	1.8	2.1	4.1	9.5	6.6
91	01546400	Spring Creek at Houserville	9.9	10.2	18.2	13.3	6.4	5.6	4.4	4.0	4.7	5.9	9.1	8.3
92	01546500	Spring Creek near Axemann	8.9	10.6	16.0	12.0	9.0	6.3	4.9	4.9	5.1	6.0	7.8	8.3
93	01547100	Spring Creek at Milesburg	8.9	9.5	14.2	10.9	8.0	7.5	5.8	5.6	6.2	6.8	8.1	8.6
94	01547200	Bald Eagle Creek below Spring Creek at Milesburg	8.2	11.3	17.8	10.7	8.5	6.0	4.8	4.4	5.0	6.2	8.5	8.7
95	01547500	Bald Eagle Creek at Blanchard	7.1	12.2	20.8	12.6	8.3	4.1	5.0	4.7	4.4	5.5	8.6	6.9
96	01547700	Marsh Creek at Blanchard	8.7	13.1	20.7	13.5	9.0	4.8	2.5	2.0	2.7	3.9	9.0	10.1
97	01547800	South Fork Beech Creek near Snow Shoe	9.3	10.4	17.4	13.3	9.3	6.4	3.2	1.7	4.2	6.0	8.5	10.4
98	01547950	Beech Creek at Monument	8.0	12.0	15.3	14.4	9.4	6.8	3.6	2.7	3.4	5.2	9.5	9.7
99	01549500	Blockhouse Creek near English Center	8.3	10.0	19.8	16.1	10.7	3.5	2.2	1.8	2.6	5.2	10.0	9.8
100	01549780	Larrys Creek at Cogan House	6.3	9.9	20.1	12.5	12.5	5.0	3.2	2.0	3.5	6.1	8.8	10.1
101	01550000	Lycoming Creek near Trout Run	8.1	9.0	19.7	16.2	10.4	4.0	2.7	2.4	3.2	5.3	9.9	9.1
102	01552000	Loyalsock Creek at Loyalsockville	8.5	9.0	18.4	15.3	10.3	3.5	2.6	2.5	3.4	5.7	11.1	9.7
103	01552500	Muncy Creek near Sonestown	8.6	10.1	17.0	13.8	9.9	3.2	3.1	2.4	4.0	6.3	11.9	9.8
104	01553130	Sand Spring Run near White Deer	9.3	8.5	18.5	11.7	11.6	4.9	2.6	2.0	3.6	7.4	10.2	9.7
105	01553600	East Branch Chillisquaque Creek near Washingtonville	10.1	14.3	19.6	9.6	9.2	4.3	0.4	1.0	1.8	5.6	8.7	15.0

Table 3. Estimates of mean-monthly recharge as a percentage of mean-annual recharge computed by the use of RORA for the period of record used at 197 streamflow-gaging stations in Pennsylvania.

Map identification number (fig. 1)	Station identification number	Station name	Mean-monthly recharge, as a percentage of mean-annual recharge											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
106	01554500	Shamokin Creek near Shamokin	8.1	9.7	13.5	12.1	12.7	6.0	5.4	4.3	4.8	5.8	8.0	9.5
107	01555000	Penns Creek at Penns Creek	8.6	10.8	19.7	14.8	10.7	5.1	3.1	2.5	3.3	4.3	8.4	8.7
108	01555500	East Mahantango Creek near Dalmatia	10.5	12.3	18.1	12.5	10.3	4.0	2.9	2.2	3.3	4.5	9.1	10.2
109	01556000	Frankstown Br Juniata River at Williamsburg	9.2	11.5	20.8	14.4	9.7	4.6	3.6	3.1	3.2	4.3	7.3	8.4
110	01556500	Little Juniata River at Tipton	11.3	13.4	16.5	16.2	11.6	5.0	3.1	2.6	1.5	3.7	6.2	8.9
111	01557500	Bald Eagle Creek at Tyrone	9.4	12.5	19.6	14.4	10.7	4.6	2.6	2.1	2.6	4.3	8.0	9.2
112	01558000	Little Juniata River at Spruce Creek	8.7	11.4	19.0	14.1	10.2	5.0	3.8	3.0	3.4	4.8	7.8	8.6
113	01559500	Standing Stone Creek near Huntingdon	11.1	10.3	20.9	17.2	11.8	3.8	2.2	2.1	1.8	3.5	6.6	8.9
114	01559700	Sulphur Springs Creek near Manns Choice	9.5	13.2	23.5	16.1	10.0	3.8	0.9	1.5	1.8	4.1	5.2	10.1
115	01560000	Dunning Creek At Beldon	9.8	13.2	22.7	13.3	9.0	3.9	2.3	1.8	2.3	3.9	7.9	9.8
116	01562500	Great Trough Creek near Marklesburg	10.0	12.8	21.5	17.9	11.2	4.1	2.8	1.6	1.3	2.7	5.7	8.5
117	01564500	Aughwick Creek near Three Springs	10.1	14.2	21.6	14.9	9.7	3.5	2.2	1.4	2.0	4.0	7.0	9.5
118	01565000	Kishacoquillas Creek at Reedsville	9.3	11.0	22.4	14.2	13.1	3.4	2.7	2.4	2.1	3.9	7.6	8.1
119	01565700	Little Lost Creek at Oakland Mills	11.9	10.6	18.2	8.6	8.7	7.1	3.4	2.9	4.0	7.4	6.4	11.0
120	01566000	Tuscarora Creek near Port Royal	10.3	14.7	19.6	15.5	10.4	3.5	2.6	2.3	2.2	3.9	6.8	8.3
121	01566500	Cocolamus Creek near Millerstown	10.5	13.7	18.4	14.6	10.9	1.9	2.0	2.0	2.3	4.4	8.5	10.7
122	01567500	Bixler Run near Loysville	9.2	13.4	20.6	11.7	8.2	5.6	3.5	2.6	3.5	5.0	7.6	9.0
123	01568000	Sherman Creek at Shermans Dale	10.5	12.7	19.4	15.3	9.8	3.4	2.4	2.2	2.4	4.4	7.7	9.8
124	01569000	Stony Creek near Dauphin	7.1	12.5	17.6	14.5	11.8	3.7	2.3	2.5	2.6	4.4	8.1	12.9
125	01570000	Conodoguinet Creek near Hogestown	9.9	12.9	15.5	13.2	9.1	5.2	4.4	3.3	4.0	4.7	8.0	9.7
126	01571000	Paxton Creek near Penbrook	7.5	11.8	19.6	12.2	10.3	2.8	4.8	3.0	2.9	4.0	11.3	9.9
127	01571500	Yellow Breeches Creek near Camp Hill	9.5	12.3	14.5	12.0	8.9	5.9	5.0	5.1	5.2	5.9	7.0	8.7
128	01572000	Lower Little Swatara Creek at Pine Grove	8.4	14.5	18.9	11.2	8.4	7.0	3.1	2.8	3.2	5.7	7.9	8.8
129	01572025	Swatara Creek near Pine Grove	13.6	10.7	17.3	9.9	9.2	5.7	3.2	1.9	3.9	5.6	9.8	9.3
130	01573000	Swatara Creek at Harper Tavern	9.9	12.2	17.2	12.4	9.7	4.3	3.5	2.7	3.4	4.9	9.0	10.8
131	01573086	Beck Creek near Cleona	10.3	9.4	14.0	10.4	10.7	9.9	4.1	5.3	4.9	6.7	5.5	9.0
132	01573160	Quittapahilla Creek near Bellegrove	9.6	8.9	12.6	10.2	8.7	7.6	7.4	5.6	5.7	6.9	7.5	9.4
133	01573500	Manada Creek at Manada Gap	9.4	12.4	16.4	13.2	12.7	3.1	4.2	2.7	2.3	4.7	8.2	10.6

Table 3. Estimates of mean-monthly recharge as a percentage of mean-annual recharge computed by the use of RORA for the period of record used at 197 streamflow-gaging stations in Pennsylvania.

Map identification number (fig. 1)	Station identification number	Station name	Mean-monthly recharge, as a percentage of mean-annual recharge											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
134	01573560	Swatara Creek near Hershey	10.2	10.9	15.9	13.3	8.7	5.2	4.3	3.0	3.8	5.8	8.7	10.1
135	01574000	West Conewago Creek near Manchester	11.7	14.3	18.8	12.8	8.5	4.0	3.0	2.0	3.0	4.1	7.7	10.2
136	01576085	Little Conestoga Creek near Churchtown	9.2	12.5	20.5	10.6	10.4	3.5	5.4	2.6	3.5	3.1	9.2	9.3
137	01576754	Conestoga River at Conestoga	12.3	9.4	17.9	8.7	9.1	5.3	5.4	3.6	5.2	5.1	8.4	9.7
138	01603500	Evitts Creek near Centerville	10.3	13.4	21.5	15.3	10.6	3.8	2.6	2.1	2.3	4.3	4.5	9.3
139	01613050	Tonoloway Creek near Needmore	11.3	13.9	18.9	13.6	10.9	4.5	2.0	0.7	2.0	4.3	8.5	9.5
140	01613500	Licking Creek near Sylvan	9.4	15.0	20.1	19.5	7.9	3.2	2.8	1.3	2.5	4.0	5.2	9.1
141	01614090	Conococheague Creek near Fayetteville	9.9	12.1	19.2	15.1	11.6	4.3	2.3	1.3	3.8	5.5	5.5	9.2
142	03007800	Allegheny River at Port Allegany	8.2	11.2	16.1	14.6	8.4	5.2	2.7	2.7	4.3	6.3	10.5	9.8
143	03008000	Newell Creek near Port Allegany	7.5	10.3	16.9	12.5	7.5	7.7	2.1	2.8	5.4	4.6	9.9	12.9
144	03009680	Potato Creek at Smethport	6.4	12.0	19.9	10.1	8.8	5.2	2.4	2.2	4.9	6.2	10.3	11.7
145	03010655	Oswayo Creek at Shinglehouse	7.7	11.9	16.4	16.1	7.1	6.3	2.9	2.4	4.0	5.3	9.0	10.9
146	03011800	Kinzua Creek near Guffey	8.2	10.3	16.7	13.4	7.4	4.8	2.6	2.9	4.3	6.3	11.8	11.4
147	03015280	Jackson Run near North Warren	12.8	7.2	21.8	11.3	5.7	3.3	2.1	2.6	4.8	4.3	12.0	12.0
148	03015500	Brokenstraw Creek at Youngsville	10.3	11.2	20.1	11.5	6.9	4.2	2.4	2.7	3.2	5.7	11.3	10.7
149	03017500	Tionesta Creek at Lynch	9.8	9.6	18.8	15.6	9.8	4.5	2.6	1.8	3.2	4.3	8.6	11.4
150	03019000	Tionesta Creek at Nebraska	12.2	10.9	19.3	15.5	9.1	3.9	2.0	1.8	2.6	3.8	8.3	10.7
151	03020500	Oil Creek at Rouseville	9.2	11.5	20.7	12.1	7.1	4.1	2.5	2.4	3.4	4.7	11.6	10.8
152	03021000	Oil Creek near Rouseville	13.9	8.3	23.1	10.8	7.8	4.4	2.1	2.6	2.9	5.0	10.2	8.8
153	03021350	French Creek near Wattsburg	10.4	12.0	21.9	7.6	4.4	3.1	1.9	3.1	3.9	6.9	13.7	11.2
154	03021410	West Branch French Creek near Lowville	10.6	14.3	20.0	3.9	3.3	2.0	1.8	3.1	4.1	9.3	14.9	12.7
155	03021500	French Creek at Carters Corners	12.9	12.1	23.0	8.5	5.3	1.9	1.5	2.0	2.5	5.7	13.2	11.4
156	03021700	Little Conneauttee Creek near McKean	11.8	13.8	24.0	7.8	3.1	2.6	0.4	1.3	2.6	4.1	16.4	12.2
157	03022540	Woodcock Creek at Blooming Valley	8.6	13.9	18.3	7.7	5.7	4.2	2.9	3.3	4.2	6.3	11.9	13.0
158	03023000	Cussewago Creek near Meadville	15.0	13.2	21.8	7.1	6.0	1.9	0.7	1.1	3.1	6.6	11.2	12.3
159	03025000	Sugar Creek at Sugarcreek	11.6	11.6	19.3	13.4	8.6	4.3	2.8	2.2	2.4	4.3	8.2	11.2
160	03025200	Patchel Run near Franklin	11.3	10.8	16.4	12.0	8.9	4.8	2.4	2.0	2.9	3.9	10.7	13.9
161	03026500	Sevenmile Run near Rasselas	8.3	10.1	18.3	15.4	8.6	4.6	2.5	2.6	3.7	5.3	10.9	9.9
162	03028000	West Branch Clarion River at Wilcox	7.6	10.3	17.3	15.8	7.4	4.8	3.0	2.7	4.2	5.5	11.1	10.3

Table 3. Estimates of mean-monthly recharge as a percentage of mean-annual recharge computed by the use of RORA for the period of record used at 197 streamflow-gaging stations in Pennsylvania.

Map identification number (fig. 1)	Station identification number	Station name	Mean-monthly recharge, as a percentage of mean-annual recharge											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
163	03029400	Toms Run at Cooksburg	10.4	8.6	19.8	13.5	9.3	5.0	2.4	1.5	2.6	4.5	8.0	14.2
164	03031950	Big Run near Sprankle Mills	12.0	7.9	19.8	10.8	7.8	3.8	2.1	3.5	3.7	5.7	9.2	13.6
165	03034000	Mahoning Creek at Punxsutawney	9.9	12.6	18.8	12.0	8.7	4.6	3.5	2.9	3.0	4.1	8.9	11.1
166	03034500	Little Mahoning Creek at McCormick	11.5	12.5	18.7	12.0	8.2	3.5	2.5	2.6	2.7	4.1	9.6	12.0
167	03035000	Mahoning Creek near Dayton	11.1	14.3	18.5	12.1	9.4	5.3	3.5	2.1	2.9	3.0	9.0	8.8
168	03038000	Crooked Creek at Idaho	11.4	13.5	19.1	13.2	8.1	4.3	2.9	2.4	2.6	3.7	7.6	11.2
169	03039200	Clear Run near Buckstown	9.1	10.4	19.1	16.3	10.2	5.0	1.5	1.2	2.1	5.5	7.4	12.4
170	03039925	North Fork Bens Creek at North Fork Reservoir	9.6	12.2	16.6	10.9	11.2	3.3	4.3	2.5	5.2	3.6	10.9	9.7
171	03042000	Blacklick Creek at Josephine	9.6	12.6	19.1	12.1	8.0	4.1	3.8	3.1	3.9	4.1	9.3	10.2
172	03042200	Little Yellow Creek near Strongstown	12.0	10.9	18.2	13.9	7.9	4.5	2.2	2.2	3.7	4.6	8.1	11.8
173	03042500	Two Lick Creek at Graceton	12.9	12.6	22.0	14.8	9.1	2.2	3.1	2.2	2.1	3.5	6.4	9.1
174	03045500	Loyalhanna Creek at New Alexandria	13.5	16.1	17.8	13.0	8.5	4.0	2.2	3.3	2.9	3.7	7.1	7.9
175	03049000	Buffalo Creek near Freeport	11.7	14.4	18.9	12.7	8.5	3.7	2.7	2.1	2.4	3.6	7.8	11.5
176	03049800	Little Pine Creek near Etna	11.7	12.7	20.8	14.5	8.6	3.5	2.9	1.6	1.9	3.4	7.4	10.9
177	03072000	Dunkard Creek at Shannopin	13.8	15.8	19.4	14.6	8.3	3.3	2.1	1.6	2.3	2.0	6.3	10.5
178	03072590	Georges Creek at Smithfield	12.7	13.7	16.2	16.6	9.1	4.6	1.3	1.2	3.2	2.8	5.2	13.5
179	03072840	Tenmile Creek near Clarksville	14.3	13.0	18.9	15.0	6.2	4.0	1.7	1.6	3.3	2.3	5.6	14.1
180	03074300	Lick Run at Hopwood	11.5	11.3	15.5	14.2	13.3	5.3	1.7	1.7	3.3	3.2	6.6	12.4
181	03074500	Redstone Creek at Waltersburg	11.3	13.1	16.2	13.0	9.0	4.6	3.9	3.6	4.0	4.2	7.2	10.1
182	03079000	Casselman River at Markleton	10.3	14.0	19.7	14.2	9.0	4.0	2.5	2.3	2.5	3.9	7.5	10.2
183	03080000	Laurel Hill Creek at Ursina	11.0	12.4	19.5	12.7	9.4	4.2	2.5	2.5	2.6	3.8	9.0	10.3
184	03082200	Poplar Run near Normalville	13.5	10.9	18.3	13.7	9.1	3.6	1.5	2.1	3.2	3.8	8.6	11.8
185	03084000	Abers Creek near Murrysville	12.4	13.4	19.8	13.1	7.7	4.1	3.3	2.7	2.4	3.9	6.5	10.6
186	03084500	Turtle Creek at Trafford	13.5	15.0	17.6	12.4	9.4	6.3	1.8	1.8	2.3	2.5	7.8	9.5
187	03086100	Big Sewickley Creek near Ambridge	14.4	10.3	19.6	13.7	11.9	3.8	1.8	0.9	2.2	3.6	5.4	12.5
188	03100000	Shenango River near Turnersville	12.3	9.6	28.2	9.1	9.1	2.8	2.3	1.5	1.1	5.1	9.2	9.6
189	03101000	Sugar Run at Pymatuning Dam	14.4	15.2	21.5	13.3	8.0	1.4	0.9	0.8	1.2	3.3	8.2	11.8
190	03102000	Shenango River near Jamestown	17.0	12.9	18.6	11.0	8.6	2.4	2.2	1.0	2.7	4.5	9.1	10.1
191	03102500	Little Shenango River at Greenville	11.2	14.0	17.9	12.3	7.3	4.2	2.3	2.2	2.7	4.3	10.0	11.5

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			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
192	03103000	Pymatuning Creek near Orangeville	15.7	15.3	18.5	14.6	7.9	3.2	2.8	1.3	1.9	3.5	5.8	9.5
193	03104760	Harthegig Run near Greenfield	9.8	13.1	20.6	10.7	5.3	4.9	1.8	3.1	3.0	5.2	9.2	13.2
194	03106000	Connoquenessing Creek near Zelienople	12.9	13.0	18.8	13.4	8.4	4.4	2.5	2.3	2.7	3.0	7.8	10.9
195	03106500	Slippery Rock Creek at Wurtemburg	13.0	12.9	20.7	10.9	8.1	4.1	2.9	2.8	2.5	4.0	7.0	10.7
196	03108000	Raccoon Creek at Moffatts Mill	11.3	16.5	20.8	12.5	10.7	3.3	2.5	2.1	1.7	3.0	5.8	9.6
197	03111150	Brush Run near Buffalo	12.0	14.6	21.7	16.1	9.2	2.1	1.4	1.4	2.1	2.8	5.2	11.1