INTRODUCTION

The Great Smoky Mountains National Park is located on the Tennessee-North Carolina border in the southern part of the Appalachian Range. The park occupies an area of about 800 square miles which is divided almost equally between the two States. Because of its beauty, location, and wide appeal, this is the nation's most visited national park. The number of visitors increased from 600,000 in 1937 to 3,000,000 in 1959 and to 7,000,000 in 1968. To serve these visitors, the National Park Service has provided campgrounds, picnic areas, scenic overlooks, nature and pioneer museums, and many miles of foot and horse trails. Most of these facilities and services require potable water supplies.

The recreational and service facilities are scattered throughout the park, and it is necessary to develop a separate water system for each. For many years, water supplies in the park were obtained mostly from springs and small streams. However, the increasing demand for water at some facilities has approached the yield of the springs. Although streams in most cases have afforded adequate supplies, the water requires treatment, which may be costly. For these reasons, ground-water supplies are being developed wherever possible to replace existing water supplies and for most new facilities. In those places where ground-water supplies are not practical, surface water may provide an adequate supply. The total volume of water removed from streams or from storage in the ground for use at park facilities is currently less than 500,000 gallons per day during the periods of heaviest usage. This water is only diverted briefly, as storage facilities are very small, and probably more than 90 percent of the water is not "consumed" but is returned either to the streams or to the ground-water system. Therefore no measurable effects on either the terrestrial or aquatic ecologic balance can be anticipated as a result of pumpage.

In order to plan effectively for the development of new facilities, the enlargement of existing facilities, and the management of the park's resources, the Park Service needs information on how much water is available at different places in the park. This report undertakes to satisfy that need. Sheet 1 covers the surface-water resources in the park and sheet 2 the ground-water resources.

Emphasis of this study was placed on evaluating the occurrence, availability, and quality of ground water. But ground water and surface water are so interrelated within an area, that one may not be examined fully without considering the other. It also must be anticipated that as park facilities are enlarged, the Park Service may find it necessary to obtain supplies for some facilities from surface-water sources. Thus, an important part of the study was devoted to the flow of streams, particularly low flows. Low flows are a limiting factor when developing a stream for water supply. Low-flow data are also essential in stream-pollution studies and for the protection of aquatic life and resident environment. Many recreational uses of the streams also depend on adequate low flows.

GENERAL HYDROLOGIC CONDITIONS

HYDROLOGIC CYCLE

The movement of water from the oceans, through the atmosphere, over and through the land, and back to the oceans is referred to as the hydrologic cycle. In the park, this cycle begins when water enters the area as moisture in the atmosphere and reaches the land surface as rain or snow. Part of this precipitation is either evaporated, transpired by plants, or temporarily stored in the soil and rocks. The remaining precipitation runs overland to join a stream.

Streamflow during a flood consists almost entirely of overland runoff. However, most streams in the park flow continuously whether it has rained recently or not. During periods of no overland runoff, streamflow is sustained by ground-water discharge from springs and from seepage directly into the stream channels.

CLIMATE

Two climatic factors play a decisive role in the hydrologic cycle in the park. The most important of these is precipitation. The other is temperature, which largely determines the amount of water evaporated and that transpired by plants. (The combined total of evaporation and transpiration is called evapotranspiration.)

Precipitation

The park is located in one of the wettest regions of the United States. Precipitation in the park as a whole averages 64 inches annually, which amounts to some 890 billion gallons. Of this, about 500 billion gallons is discharged from the park during the year through streams and rivers. The remaining 390 billion gallons is either evaporated, transpired by plants, or seeps from the area through permeable rocks beneath the ground.

Precipitation at points within the park ranges from less than 50 to more than 80 inches per year (surface-water availability map). In general, the amount of precipitation increases with increasing altitude. Differences in average annual precipitation of more than 25 inches between a rain gage in a valley and one on a peak less than 10 miles away (fig. 1) are not uncommon.

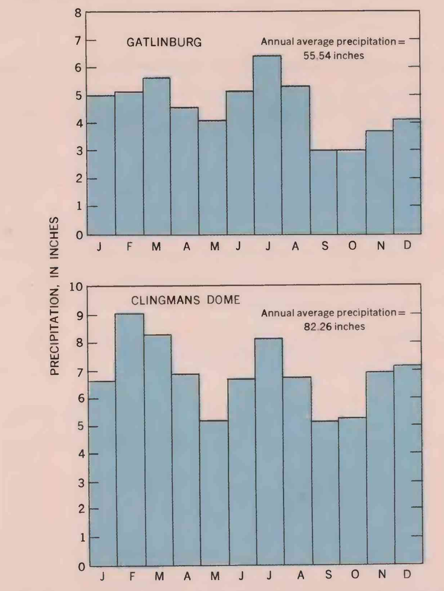


Figure 1.—*Average monthly precipitation at Gatlinburg (altitude 1,460 ft) and at Clingmans Dome (alt. 6,250 ft). After TVA (1968).*

Precipitation also varies from year to year. For example, over the upper Little Tennessee River basin, which includes the southern part of the park, precipitation has ranged during the past 33 years from a low of 54 inches in 1952 to a high of 77 inches in 1964 (TVA, 1968).

On a seasonal basis, the winter and spring tend to be much wetter than the summer and fall. March is usually the wettest month and October the driest (fig. 2); long-term averages indicate that only about half as much precipitation occurs in October as in March.

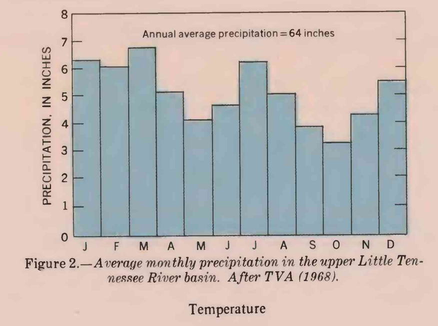


Figure 2.—*Average monthly precipitation in the upper Little Tennessee River basin. After TVA (1968).*

Temperature

The variations of evapotranspiration losses with time are related to seasonal changes in temperature. An example is the low streamflow generally experienced in late summer and early fall. This is caused, in part, by the higher temperatures of summer, which increase evaporation and transpiration, reducing the ground-water supplies. Areal variations in evapotranspiration, however, are related closely to altitude. This is due primarily to the decrease in average annual temperature of about 2°F for each 1,000 foot increase in altitude. (Shanks, 1954.)

LAND SURFACE

Many factors influencing the availability of water resources within an area are related to the nature of the land surface. These factors are mostly topographic, such as altitude, slope, and drainage pattern, but also include vegetation and ground cover.

Topography

The dominant topographic feature of the park is the northeastward trending ridgeline of the Great Smoky Mountains, which forms the boundary between North Carolina and Tennessee. Sixteen peaks along this ridge are above 6,000 feet in altitude. Lesser ridges form radiating spurs from the central ridgeline. In broad aspect, the topography of the park consists of moderately sharp-crested, steep-sided ridges separated by deep, V-shaped valleys. Slopes of 50 percent (50 feet vertically in 100 feet horizontally) are common along the sides of ridges. Altitude ranges from 840 feet at the mouth of Abrams Creek at the extreme western end of the park to 6,642 feet at Clingmans Dome near the center of the park.

The central ridgeline is a major drainage divide in the park, but it is breached immediately beyond the park boundaries to the northeast by the Pigeon River and to the southwest by the Little Tennessee River. The streams of the park flow outward from the central ridgeline in every direction. All the streams are relatively small, none draining an area of more than 200 sq mi (square miles); most are much smaller than this where they flow from the park.

The drainage system is characterized by a dense network of small streams flowing through steeply-sloping channels to the Tennessee River or its tributaries. Stream slopes average nearly 400 feet per mile of channel. The slopes increase to as much as 2,000 feet per mile in the headwaters.

Vegetation

Most of the park is covered with forest; layers of leaves on the ground, tree roots, and ground vegetation reduce overland runoff, inhibit erosion, and cause a low sediment load, so that the streams are nearly always clear and sparkling. During the growing season, vegetation transpires a significant part of the water resources of the region.

SURFACE-WATER RESOURCES

Streamflow in the park is variable with respect to both time and location. The amount of flow passing a particular point may vary by as much as a factor of 10,000 from minimum flow to maximum flood. The low-flow yield of two basins of equal size may differ by a factor of 10 or more.

The four principal factors that affect streamflow are drainage area, precipitation, evapotranspiration, and—for low flows—geology.

Streamflow is usually reported in units of cubic feet per second (cfs) or of cubic feet per second per square miles (cfsm). This latter form represents the flow from each square mile of drainage basin, and is used to compare the yield of basins of different size.

AVERAGE FLOW

Average flow is a limiting factor in the design of a water supply. If all the water flowing past a point could be stored and no losses subsequently occurred, such as evaporation or seepage, then average flow would be the maximum constant rate at which water could be used.

The average flows for selected sites are given in table 1. The surface-water availability map shows the location of each of these sites by number. Average discharge shown in table 1 ranges from less than 2 to more than 4 cfsm. Thus, some streams in the park yield twice as much water per unit area as do other streams. This variability from place to place is the result of variations in precipitation and evapotranspiration.

LOW FLOW

Effective planning for utilization of a stream requires some knowledge of the low-flow characteristics of the stream. For example, demands on a water supply are highest during the hot, dry months of late summer and fall when streamflow is lowest.

A convenient and frequently-used parameter which indicates the behavior of a stream during periods of low flow is the 7-day, 2-year minimum flow; the annual 7-day minimum flow will be less than this value at average intervals of 2 years. This parameter is useful in comparing the low-flow yields at two or more stream sites, as might be necessary when planning a water supply, or estimating the capacity of a stream to dilute and transport a pollutant such as sewage, still reserving in the stream water of sufficient quality and quantity to meet ecological needs. The 7-day, 2-year flow (table 1) was determined for the same sites as those for which average flow was determined.

The low flows of the streams are more variable than the average flows. Seven-day, 2-year minimum flows range from less than 0.1 to more than 0.8 cfsm.

SPRINGS

Although the numerous springs in the park are more common at lower altitudes, they also occur on the upper slopes and in the gaps. Springs have been widely used as sources of water supplies in the park, especially at isolated trail camps. One disadvantage of depending on springs as a source of water supply is variability of flow. Also, the dependable yield of most springs in the park is small compared with the yield of wells or streams. Another disadvantage is that they may be subject to contamination. On the other hand, springs often occur at altitudes above perennial streams and at places inaccessible to well-drilling machines.

The flow of a spring which supplies water for the facilities at Newfound Gap (altitude, about 5,000 feet) was measured occasionally during the course of this study. A spring at nearby Indian Gap, about the same size and altitude, also was measured. The results of these measurements are given in the following table. It is not intended that these data be used to draw any general conclusions about other springs in the park, for these two springs are not necessarily typical. However, the discharges do indicate the variability of spring discharge.

Discharge measurements of two springs

Date	Discharge (gpm): Newfound Gap Spring	Discharge (gpm): Indian Gap Spring
7–27–66	20.6	12.7
8–18–66	51.2	62.5
8–31–66	50.0	25.0
9–28–66	46.2	35.3
11– 1–66	50.0	33.3
4–20–67	18.8	16.7
11–16–67	40.0	21.4
8–28–68	17.1	24.0
9–25–68	25.0	30.0

SURFACE-WATER DEVELOPMENT

Two methods for determining the amount of surface water available for development described below:

Method 1.—The data given in table 1 may be used to evaluate the flow at any of the listed sites. If, however, data are needed on a nearby ungaged site either upstream or downstream from a site listed in table 1, the streamflow parameters may be transferred by multiplying them by the drainage area at the ungaged site. For example, from table 1, sites 4606.20 and 4606.25 on Big Creek have 7-day, 2-year minimum flows of 0.42 cfsm and 0.38 cfsm, respectively. If we did not have data at site 4606.25, the 7-day, 2-year minimum flow could be estimated from that at site 4606.20 by multiplying the 0.42 cfsm listed for site 4606.20 by the drainage area at site 4606.25, 33.0 sq mi. This provides an estimate of about 14 cfs.

$$33.0 \text{ sq mi} \times 0.42 \text{ cfsm} = 13.9 \text{ cfs}$$

This agrees, within acceptable limits of accuracy, with the value determined for site 4606.25, which may be computed from table 1 to be about 12.5 cfs.

$$33.0 \text{ sq mi} \times 0.38 \text{ cfsm} = 12.5 \text{ cfs}$$

Another technique using this method is to combine the flow of two upstream sites located on tributaries to estimate the flow at an ungaged site downstream from their confluence. For example, suppose it is necessary to estimate the 7-day, 2-year minimum flow at site 5127.40 on Deep Creek. We have data listed in table 1 for site 5126.10 on Deep Creek and for site 5126.40 on Indian Creek, both of which are upstream from site 5127.40. The 7-day, 2-year minimum flow for station 5127.40 could be estimated by multiplying the drainage area by the 7-day, 2-year minimum flow for each of the upstream sites, adding the results, and dividing by the combined drainage area of the upstream sites. This provides a value of 0.77 cfsm.

$$29.7 \text{ sq mi} \times 0.80 \text{ cfsm} = 23.8 \text{ cfs} \qquad \text{(site 5126.10)}$$

$$6.85 \text{ sq mi} \times 0.65 \text{ cfsm} = 4.5 \text{ cfs} \qquad \text{(site 5126.40)}$$

$$\frac{(23.8 + 4.5) \text{ cfs}}{(29.7 + 6.85) \text{ sq mi}} = \frac{28.3}{36.55} \text{ cfsm} = 0.77 \text{ cfsm}$$

This value may now be transferred downstream, as was done in the preceding example, which gives an estimate of the 7-day, 2-year minimum flow at site 5127.4 of about 31 cfs.

$$40.2 \text{ sq mi} \times 0.77 \text{ cfsm} = 31.0 \text{ cfs}$$

This estimate compares quite closely with the value that may be computed from table 1 of approximately 30 cfs.

$$40.2 \text{ sq mi} \times 0.75 \text{ cfsm} = 30.2 \text{ cfs}$$

Caution should be exercised when transferring data by this method. The examples shown above were selected because they gave good estimates. Errors of estimation could be much larger in other instances. If data are transferred along a stream that flows through dissimilar hydrologic regions and if the difference in drainage areas is too large, the estimated value may be in considerable error. To minimize these errors, one drainage area should not be over 2 or 3 times larger than the other and they should be on the same stream.

Method 2.—The criterion for keeping the errors of estimate within reason when using method 1 for determining flow parameters at ungaged sites leaves many miles of streams within the park where the data listed in table 1 cannot be used directly.

Therefore, a second method was developed to estimate streamflow data at any point in the park and to give a more complete picture of the surface-water hydrology. A regression analysis was made of the average and the 7-day, 2-year minimum flows in table 1 versus various climatic, physical, and geologic factors, which might affect streamflow in the park. The results of this analysis showed drainage area, mean basin altitude, and mean annual precipitation to be the most significant of the basin characteristics considered. The equations developed in the analysis are:

$$Q_A = 0.000959 \; E^{0.3378} \; P^{1.265} \qquad (1)$$

$${}_7Q_2 = 0.000171 \; E^{1.740} \; P^{-1.555} \qquad (2)^a$$

where Q_A = average discharge, in cfsm;

${}_7Q_2$ = 7-day, 2-year minimum discharge, in cfsm;

E = mean basin altitude, in feet;

and P = mean annual precipitation, in inches.

[a] It may be noted that the power to which mean annual precipitation is raised in the equation for estimating 7-day, 2-year minimum flows is negative. This indicates that this discharge parameter is inversely related to precipitation and yet common sense tells us this is not true. Actually these equations are statistical rather than functional in nature. Therefore, what the equation indicates is that in most instances where high precipitation occurs in the study area 7-day, 2-year flows are low and conversely, where precipitation is less, flow is more. The equation should not be interpreted to say that high precipitation causes low 7-day, 2-year minimum discharges. Other factors, probably geologic in nature, occur in a pattern closely paralleling that of mean annual precipitation and probably cause this inverse relationship.

Equations 1 and 2 may be solved mathematically or by using the surface-water availability map and figures 3 and 4. To estimate the average flow or the 7-day, 2-year minimum flow from surface-water availability map and figures 3 and 4 the following procedure should be used:

1. Sketch the drainage basin on the map and determine the area of the basin.
2. Determine the mean basin altitude using the topography of the basin; 1,000-foot topographic contours have been accentuated on the map to assist in this determination.
3. Determine the mean annual precipitation of the basin using the lines of equal precipitation on the map.
4. Using the values determined for mean basin altitude and mean annual precipitation, estimate the average flow from figure 3 and the 7-day, 2-year minimum flow from figure 4.

Example:

1. Determined: Area of drainage basin = 5 square miles; mean basin altitude = 4,000 feet; and mean annual precipitation = 60 inches.
2. Enter figure 3 on the bottom scale at the 4,000-foot altitude point and locate the intersection with the 60-inch precipitation curve. The average discharge is then read on the left-hand scale opposite this point. For the example, the average discharge is 2.8 cfsm. This value is multiplied by the drainage area, 5 square miles, to obtain the average discharge of 14 cfs.
3. Enter figure 4 on the bottom scale at the 4,000-foot altitude point and locate the intersection with the 60-inch precipitation curve. The 7-day, 2-year discharge is then read on the left-hand scale opposite this point. For the example the 7-day, 2-year discharge is 0.54 cfsm. This value is multiplied by the drainage area, 5 square miles, to obtain the 7-day, 2-year discharge of 2.7 cfs.

NOTE: The average standard error of estimate for average flow is 21 percent, for 7-day, 2-year flow is 50 percent. These errors that occur when estimating flow parameters are primarily because equations 1 and 2 are simplifications of the complex and incompletely known set of variables that control the flow regimen of the stream.

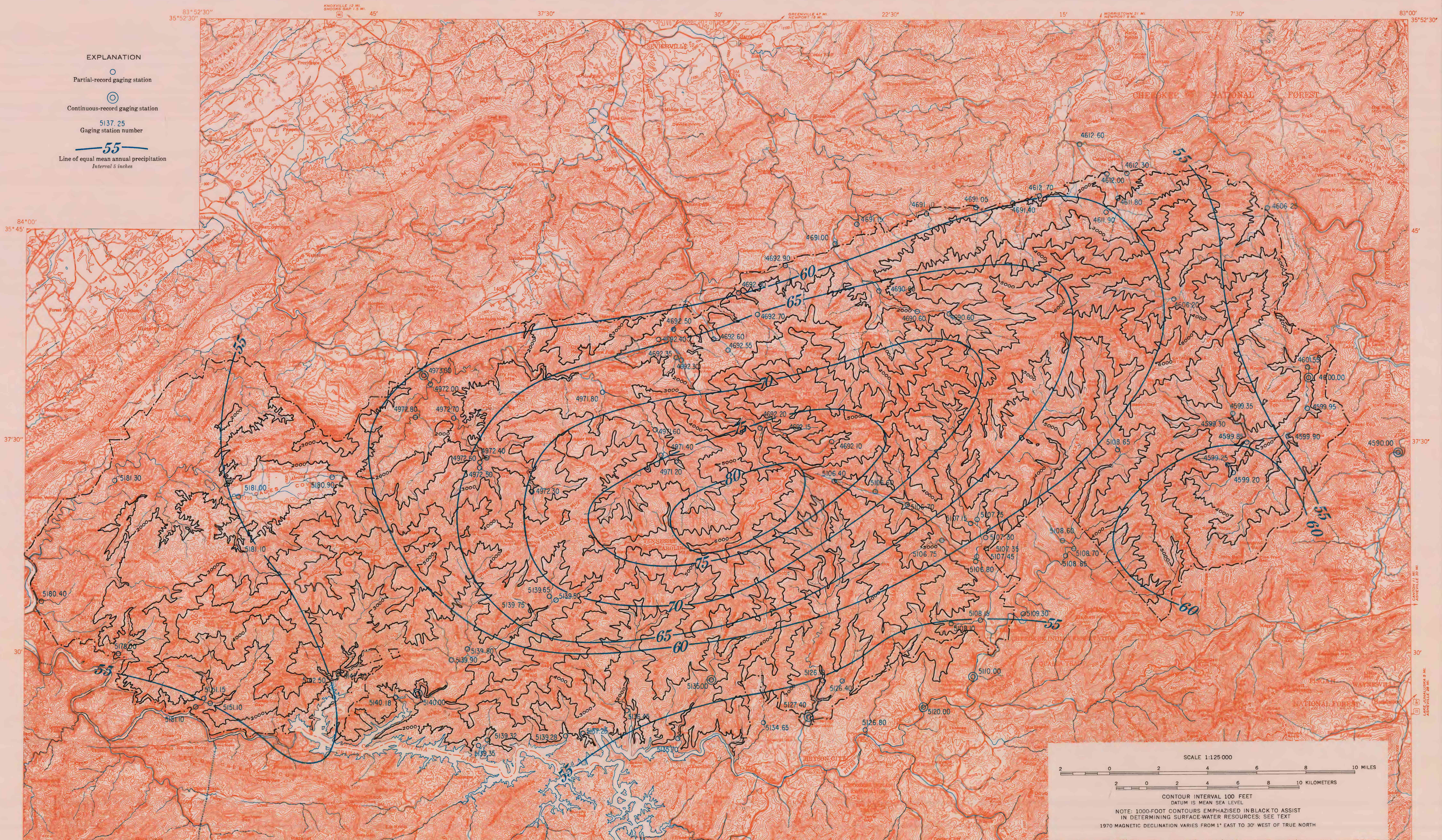
Although the 7-day, 2-year minimum flow is a useful figure for comparing the relative yields of streams, longer recurrence intervals are needed for the actual design of water-supply systems. The magnitude of low flows having 20-year recurrence intervals is sufficient, in most cases, for designing a dependable supply. A water supply designed for this flow could be expected to be deficient only once in 20 years, on the average.

The 7-day, 2-year minimum flow divided by the drainage area may be used as an index to give the storage required for any draft rate, based on the minimum flow expected to occur, on the average, once every 20 years (fig. 5). In developing these relations no allowances have been made for evaporation, seepage or for loss of storage capacity resulting from deposition of sediment in an impoundment. Since an impoundment or reservoir could not be considered in the park, the relation for zero storage may be the most important to the Park Service. This relation assumes that the water-supply intake is positioned so that it could pump all the flow in the stream. These curves are included to help in planning ways to protect the ecosystem from over-utilization. They could, in theory, provide a method to maintain fish life and to maintain the resident environment.

Standard errors of estimate of the draft rates in the relations shown in figure 5 are as follows:

Relation (ac-ft per sq mi)	Standard error (cfs per sq mi)
200	0.21
150	.14
100	.10
60	.07
20	.08
10	.06
3	.05
0	.05

These standard errors do not reflect the errors involved in estimating 7-day, 2-year minimum flow from altitude and precipitation.



SURFACE-WATER AVAILABILITY MAP

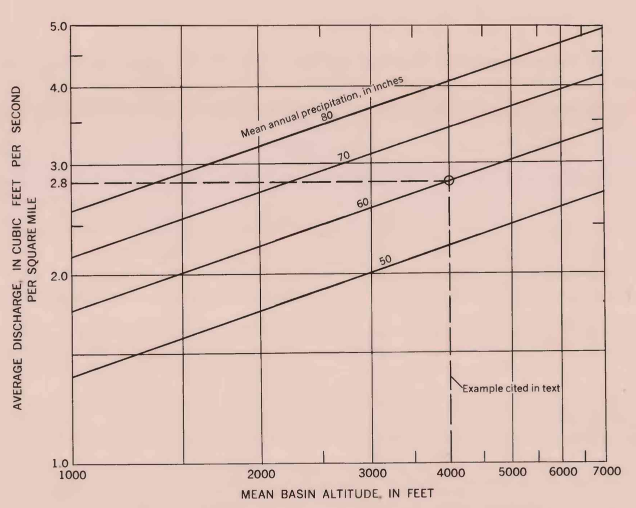


Figure 3.—*Relation for estimating average flow of a stream using mean basin altitude and mean annual precipitation.*

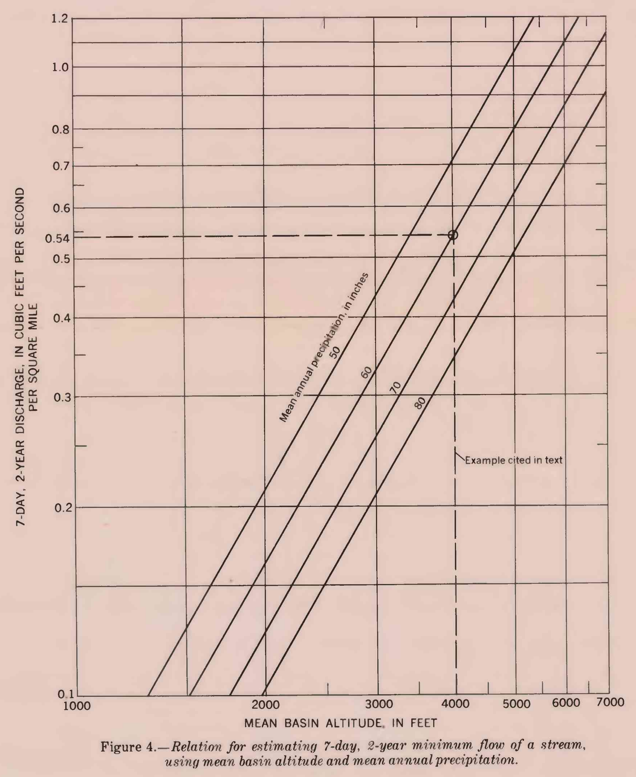


Figure 4.—*Relation for estimating 7-day, 2-year minimum flow of a stream, using mean basin altitude and mean annual precipitation.*

Example: To find the amount of storage needed to supply a draft of 0.9 cfs per sq mi from a site on a stream having a 7-day, 2-year minimum flow of 0.6 cfs per sq mi, enter at the values on the graph and find their point of intersection. This is shown by the dashed lines on figure 5. The storage required is 100 acre-feet per sq mi, which would be inadequate once every 20 years on an average.
Note also that where storage cannot be provided, the zero storage relation may be used which will give the allowable draft that may be pumped directly from the stream.

Figure 5.—*Relation for estimating the amount of storage required in a reservoir designed for any draft rate (withdrawal) using the 7-day, 2-year minimum flow of the stream as an index for entering the graph.*

Table 1.—*Streamflow characteristics of selected sites*

Site number	Stream name	Drainage area (sq mi)	Average flow (cfsm)	7-day, 2-year minimum flow (cfsm)	Site number	Stream name	Drainage area (sq mi)	Average flow (cfsm)	7-day, 2-year minimum flow (cfsm)
4590.00	Jonathan Creek	65.3	2.0	0.58	4972.90	Middle Prong Little River	45.9	2.4	0.26
4599.20	Rough Fork	6.10	2.9	.43	4973.00	Little River	106	2.9	.36
4599.25	Messer Fork	1.55	2.5	.14	*4985.00	do	269	1.9	.28
4599.30	Palmer Creek	12.9	1.9	.40	5106.40	Beech Flats Prong	.81	4.6	.72
4599.35	Pretty Hollow Creek	4.46	2.3	.81	5106.6	Jack Bradley Branch	.59	4.0	.44
4599.85	Mossy Branch	.83	1.7	.35	5106.70	Oconaluftee River	12.1	4.1	.53
4599.90	Caldwell Fork	15.8	2.2	.54	5106.75	Collins Creek	3.65	3.7	.51
4599.95	Winding Stair Branch	2.08	1.9	.32	5106.80	Oconaluftee River	20.7	3.0	.84
4600.00	Cataloochee Creek	49.2	2.2	.56	5107.15	Bradley Fork	14.0	3.1	.67
4601.55	Little Cataloochee Creek	8.46	2.1	.44	5107.25	Chasteen Creek	4.01	3.5	.63
4606.20	Big Creek	13.4	2.2	.42	5107.30	Carver Branch	.48	2.9	.45
4606.25	do	33.0	1.7	.38	5107.35	Carver Branch tributary	.12	2.8	.22
4611.80	Cosby Creek	7.51	2.3	.37	5107.40	Bradley Fork	20.0	2.9	.72
4611.90	Crying Creek tributary	.32	2.0	.35	5108.10	Mingus Creek	2.58	4.0	.84
4612.00	Cosby Creek	10.2	1.6	.38	5108.15	do	4.70	3.0	.73
4612.30	Caney Creek	1.62	2.0	.19	5108.60	Raven Fork	23.2	3.0	.80
4612.60	do	5.22	1.6	.16	5108.65	Straight Fork	10.7	3.0	.71
4612.70	Indian Camp Creek	5.25	2.7	.51	5108.70	Raven Fork	47.7	3.0	.73
4690.50	Middle Prong Little Pigeon River	10.9	3.3	.44	5108.85	Bunches Creek	16.2	3.2	.71
4690.60	do	18.2	3.0	.54	5109.30	Raven Fork	72.0	3.0	.70
4690.80	Little Pigeon River	38.5	2.9	.49	5110.00	Oconaluftee River	131	3.2	.81
4691.00	do	46.1	3.0	.24	5120.00	do	184	2.8	.74
4691.05	Webb Creek	3.74	2.2	.15	5120.80	Cooper Creek	7.10	3.1	.69
4691.10	Ramsey Creek	2.18	2.2	.35	5126.10	Deep Creek	29.7	3.3	.80
4691.15	Lindsey Creek	.54	2.1	.20	5126.40	Indian Creek	6.85	3.5	.65
4691.40	Dunn Creek	2.60	2.4	.49	5127.40	Deep Creek	40.2	3.1	.75
4692.10	Walker Camp Prong	1.65	4.4	.11	5134.65	Lands Creek	2.52	3.5	.33
4692.15	Alum Cave Creek	2.17	4.4	.27	5135.00	Noland Creek	13.8	3.2	.72
4692.20	Road Prong	3.50	4.6	.29	5135.70	do	20.3	3.0	.82
4692.25	West Prong Little Pigeon River	13.6	4.5	.34	5136.45	Forney Creek	27.7	4.0	.84
4692.30	do	20.0	4.2	.38	5137.25	Monteith Branch	.17	2.3	.23
4692.35	Sugarland Branch	1.44	3.2	.18	5139.20	Chambers Creek	5.21	2.9	.70
4692.40	Fighting Creek	4.59	2.3	.19	5139.35	Clark Branch	.31	2.7	.32
4692.50	Twomile Branch	1.13	3.0	.05	5139.50	Hazel Creek	4.18	4.2	.62
4692.55	Le Conte Creek	1.53	2.9	.44	5139.65	Proctor Creek	4.89	4.3	.74
4692.60	do	3.33	3.4	.18	5139.75	Walker Creek	2.88	3.7	.66
4692.70	Roaring Fork	4.20	3.0	.58	5139.80	Bone Valley Creek	12.0	3.3	.47
4692.80	do	6.30	2.8	.41	5139.90	Sugar Fork Creek	5.06	3.0	.50
4692.90	Dudley Creek	3.89	2.4	.15	5140.00	Hazel Creek	44.4	3.1	.70
*4700.00	Little Pigeon River	355	1.6	.20	5140.18	Hickory Bottom Branch	.75	2.8	.34
4971.20	Little River above Rough Creek	10.2	4.7	.27	5142.30	Eagle Creek	22.3	3.1	.42
4971.40	Fish Camp Prong	11.5	4.3	.64	5142.50	Lost Cove Creek	3.36	3.6	.43
4971.60	Little River	27.6	3.4	.44	5151.10	Twenty Mile Creek	8.15	3.2	.47
4971.80	do	31.4	4.2	.42	5151.15	do	14.8	3.1	.41
4972.00	do	60.1	3.1	.39	5151.20	do	15.1	3.9	.55
4972.30	Indian Flats Prong	2.57	3.0	.36	5178.00	Parson Branch	5.84	1.6	.21
4972.40	Lynn Camp Prong	12.0	3.8	.33	5180.40	Shop Creek	2.01	1.4	.02
4972.50	Thunderhead Prong	4.17	3.5	.35	5180.90	Abrams Creek	4.77	2.3	.21
4972.60	do	8.72	3.5	.31	5181.00	do	18.8	1.8	.27
4972.70	Middle Prong Little River	25.7	3.2	.32	5181.10	Forge Creek	7.92	3.6	.28
4972.80	West Prong Little River	8.24	2.2	.35	5181.30	Abrams Creek	60.3	7.9	.23

*Not shown on surface-water availability map.

WATER RESOURCES OF THE GREAT SMOKY MOUNTAINS NATIONAL PARK, TENNESSEE AND NORTH CAROLINA

By
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