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No. 63

HYDROGRAPHY OF THE SOUTHERN APPALACHIAN MOUNTAIN REGION, PART II.—PRESSEY

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

HYDROGRAPHY

OF THE

SOUTHERN APPALACHIAN MOUNTAIN REGION

PART II

By HENRY ALBERT PRESSEY

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

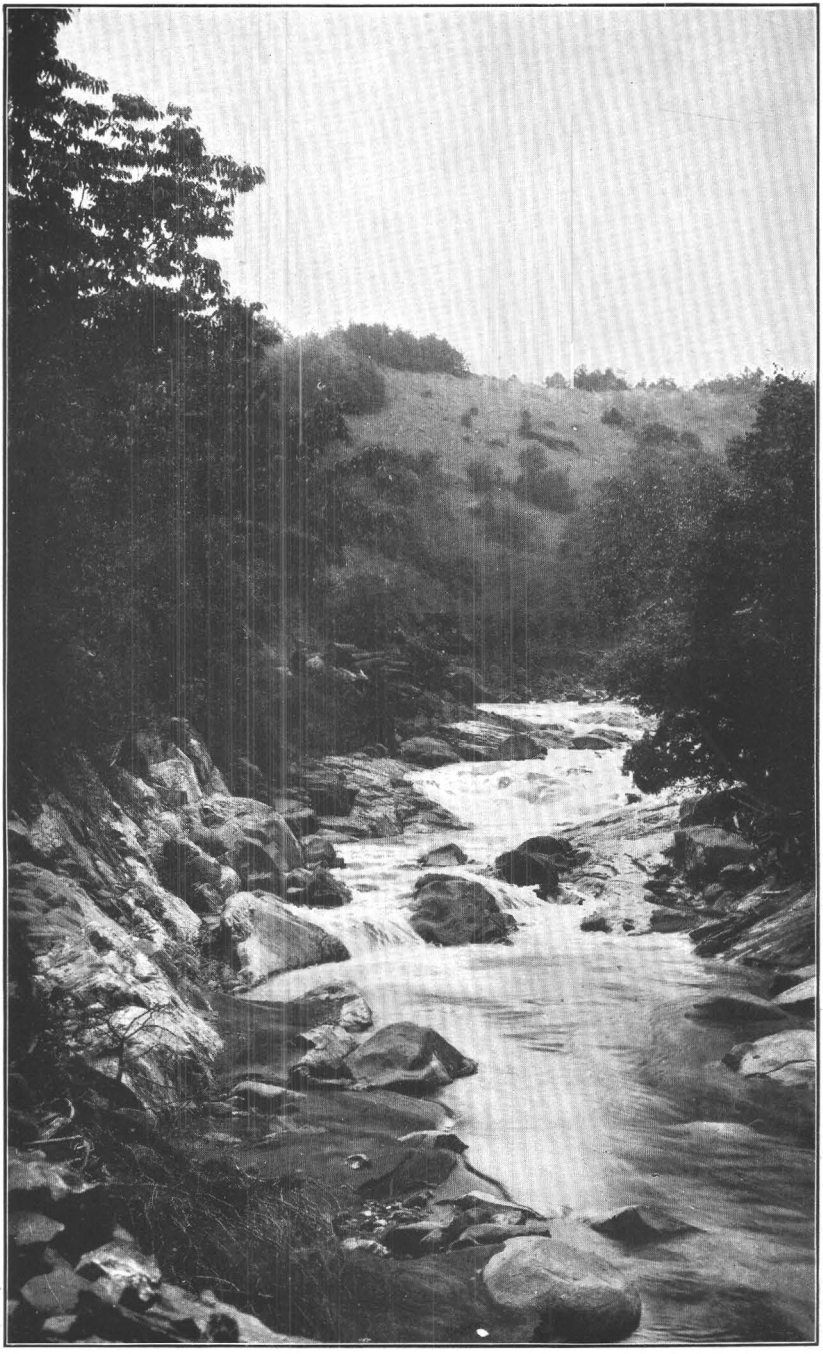
CONTENTS.

	Page.
Drainage basins—Continued	105
Nolichucky River	105
Physical features	106
Rainfall	106
Forests	106
Minerals	106
Discharge measurements	107
Water powers	107
Tributaries of Nolichucky River	108
Discharge measurements	108
North Indian Creek	110
South Indian Creek	110
Hollow Poplar Creek	111
North Toe River	111
South Toe River	114
Caney River	114
French Broad River	115
General features	115
Watershed in North Carolina	116
Watershed in Tennessee	121
Rainfall	123
Transportation	124
Discharge measurements	124
Water powers	125
Tributaries of French Broad River	127
Discharge measurements	127
Long Creek	129
Big Creek	129
Laurel Branch, Mooneyham Branch, and Rock Creek	129
Wolf Creek	129
Shutin Creek	130
Spring Creek	130
Big Laurel Creek	130
Shelton Laurel Creek	131
Big Pine Creek	131
Walnut, Little Pine, and Hayes creeks	132
Ivy River	132
Sandymush Creek	134
Turkey Creek	134
Flat Creek	134
Reems, Newfound, and Beaverdam creeks	135
Saluda River	135
North Saluda River	136
Middle Saluda River	137
South Saluda River	137
Discharge measurements	138
Broad River	139
Physical features	139
Rainfall	140
Forests	140

Drainage basins—Continued. Page.
Broad River—Continued.
Minerals ... 140
Discharge measurements ... 141
Water-powers ... 142
Tributaries of Broad River ... 143
Discharge measurements ... 143
First Broad River ... 143
Second Broad River ... 144
Green River ... 145
Catawba River ... 147
Physical features ... 147
Rainfall ... 148
Forests ... 148
Discharge measurements ... 148
Water powers ... 150
Tributaries of Catawba River ... 151
Discharge measurements ... 151
Center, Crib, Clear, and Buck creeks ... 152
North Fork of Catawba River ... 153
Paddy Creek ... 153
Linville River ... 153
Cane Creek ... 155
Upper Creek ... 156
John River ... 157
Lower Creek ... 158
Yadkin River ... 158
Physical features ... 158
Soils ... 160
Forests ... 161
Discharge measurements ... 161
Water powers ... 162
Tributaries of Yadkin River ... 164
Discharge measurements ... 164
Elk Creek ... 165
Stony Creek ... 165
Louis Fork ... 165
Unnamed tributary east of Louis Fork ... 166
Reddie River ... 166
Mulberry River ... 166
Roaring River ... 167
Big Elkin River ... 167
Mitchell River ... 168
Fisher River ... 168
Ararat River ... 169
New River ... 169
South Fork of New River ... 171
General features ... 171
Discharge measurements in basin ... 172
Water powers in basin ... 173
North Fork of New River ... 173
General features ... 173
Discharge measurements in basin ... 174
Water powers in basin ... 174
Streams southwest of French Broad River ... 175
Index ... 183

ILLUSTRATIONS.

		Page.
PLATE XXVI.	Cane Creek, tributary of Nolichucky River, showing characteristic rocky bed of mountain streams	105
XXVII.	Gorge of Nolichucky River	106
XXVIII.	View showing effect of floods on Nolichucky River	106
XXIX.	*A*, Splash dam on Little River, Tennessee; *B*, Combined sawmill and gristmill on Price Creek, Yancey County, N. C	108
XXX.	Swannanoa Rapids on Swannanoa River, North Carolina	118
XXXI.	French Broad River at Paint Rock, N. C	120
XXXII.	Mountain Island Shoal, French Broad River, North Carolina	124
XXXIII.	Hickory Nut Gap from Chimney Rock, North Carolina	140
XXXIV.	Hickory Nut Creek, North Carolina	140
XXXV.	Falls on upper Catawba River, North Carolina	146
XXXVI.	*A* and *B*, Views showing hillside wash in valley of Catawba River	148
XXXVII.	*A*, View showing removal of soil in valley by floods; *B*, View in valley of Catawba River, showing destruction by floods	148
XXXVIII.	Lower falls of Linville River, North Carolina	154
XXXIX.	Lower falls of Cullasagee Creek, North Carolina, a tributary of Little Tennessee River	174
XL.	Oconalufty Valley, North Carolina	174
XLI.	Tuckasegee River near Dillsboro, N. C	176
XLII.	Tuckasegee Falls, North Carolina	176
XLIII.	Water-power development on Tuckasegee River near Painter, N. C	178
XLIV.	Okoee River near Ducktown, Tenn	178



CANE CREEK, TRIBUTARY OF NOLICHUCKY RIVER, SHOWING CHARACTERISTIC ROCKY BED OF MOUNTAIN STREAMS.

HYDROGRAPHY OF THE SOUTHERN APPALACHIAN MOUNTAIN REGION.

PART II.

By HENRY A. PRESSEY.

DRAINAGE BASINS—Continued.[a]

NOLICHUCKY RIVER.

PHYSICAL FEATURES.

This river is formed by the junction of Toe River and Caney River about 8 or 9 miles east of the Tennessee State line. Toe River is formed by the union of the North Toe and the South Toe between Sevenmile Ridge and the Burn Mountains. The area drained by the Nolichucky in North Carolina is in the high mountains within the limits of Yancey and Mitchell counties.

Yancey County is preeminently mountainous, the Black Mountains penetrating it from the southeast and extending to its center, or to near Burnsville. The great Unaka Range separates the county from Tennessee, and numerous cross chains intersect its surface in all directions, leaving very little valley land except along the banks of the streams. As elsewhere in the region, the mountains here are fertile to the top, being covered with a deep and friable soil which bears trees of great size, and where cultivated produces all of the grains and grasses, as well as very excellent fruits, the apples being especially fine. Cattle raising is an important industry.

Mitchell County lies between the Blue Ridge on the south and east and the Unakas on the north, and like Yancey County is very mountainous, there being little valley land except along the headwaters of Toe River. The cultivated lands are very fertile. All of the cereals grow well, grasses flourish, and fruits of very fine quality are produced in abundance.

The tributaries, like the main stream, rise near the summits of the mountain chains and flow over rocky and precipitious beds through narrow valleys. One of these rocky stream beds is shown in Pl. XXVI, a view of Cane Creek, one of the large tributaries of the Nolichucky.

[a] Continued from Part I, Water-Supply Paper No. 62.

The river first flows almost north for several miles, then turns toward the northwest and flows in a deep gorge through the Unaka Mountains (see Pl. XXVII) and into Tennessee, where preserving its general westerly direction it finally enters French Broad River about 7½ miles southeast of Morristown, draining a total area of 640 square miles above the Tennessee line, comprising almost all of Mitchell County and all of Yancey County. It leaves the mountains near Embreville, Tenn., which was the western limit of the investigation, although some observations were made of the character of the country lying to the west, sufficient to establish the fact that it differed in no important respects from the area already described as the Valley of East Tennessee.

None of the small closed drainage basins or sinks which are so numerous in the valley of the Holston were seen in the basin of the Nolichucky, but there seems to be a greater number of large springs.

RAINFALL.

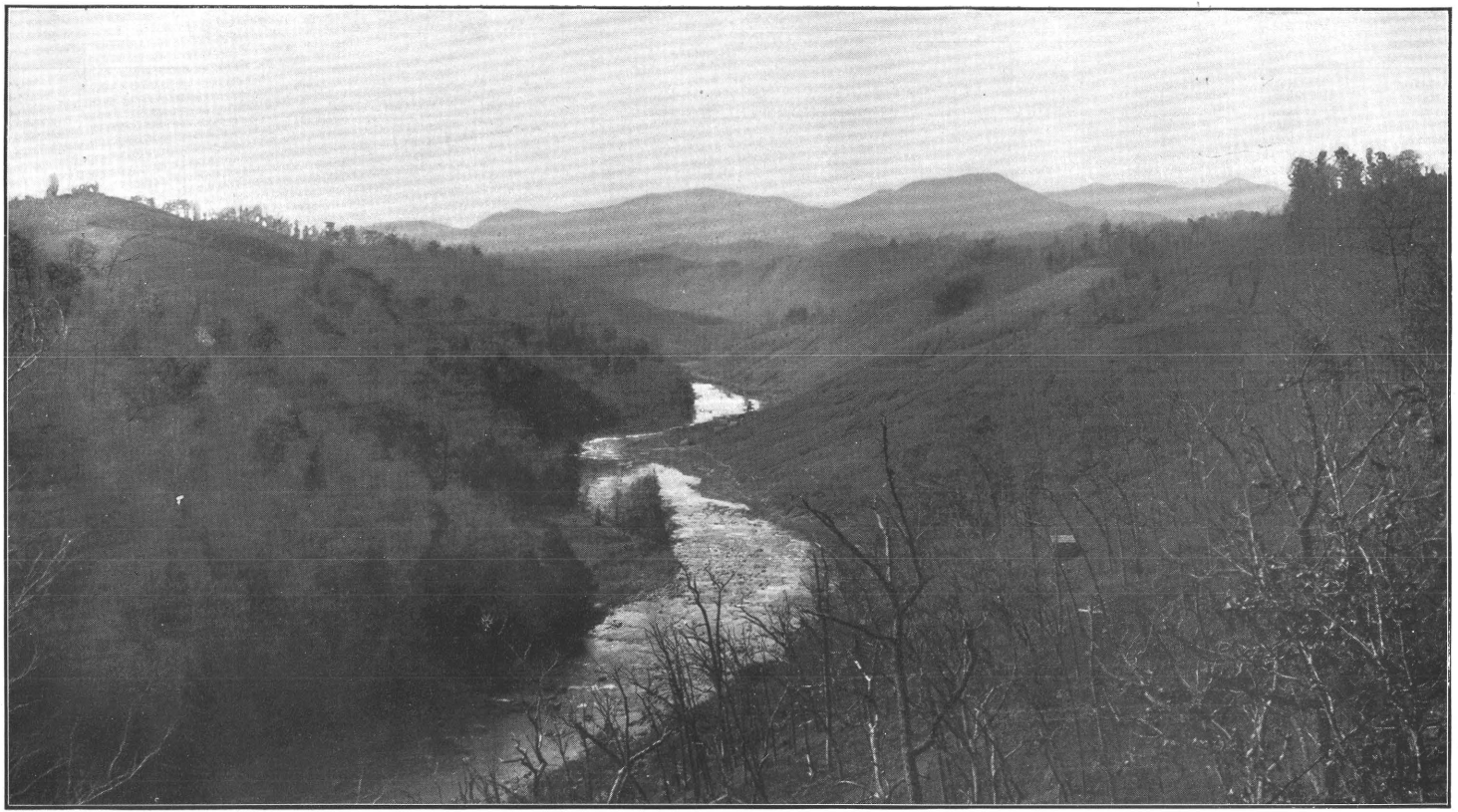
The rainfall over the basin is about 51.2 inches per annum, 11.4 inches of which falls in the spring, 15.7 inches in the summer, 11.6 inches in the autumn, and 13.5 inches in the winter. The whole area is subject to sudden and violent rains, producing great floods, while in the winter the ice moving downstream sometimes forms ice dams which do a great deal of damage. The streams are therefore of much less value as sources of power than they otherwise would be. The effect of floods on the Nolichucky is shown in Pl. XXVIII.

FORESTS.

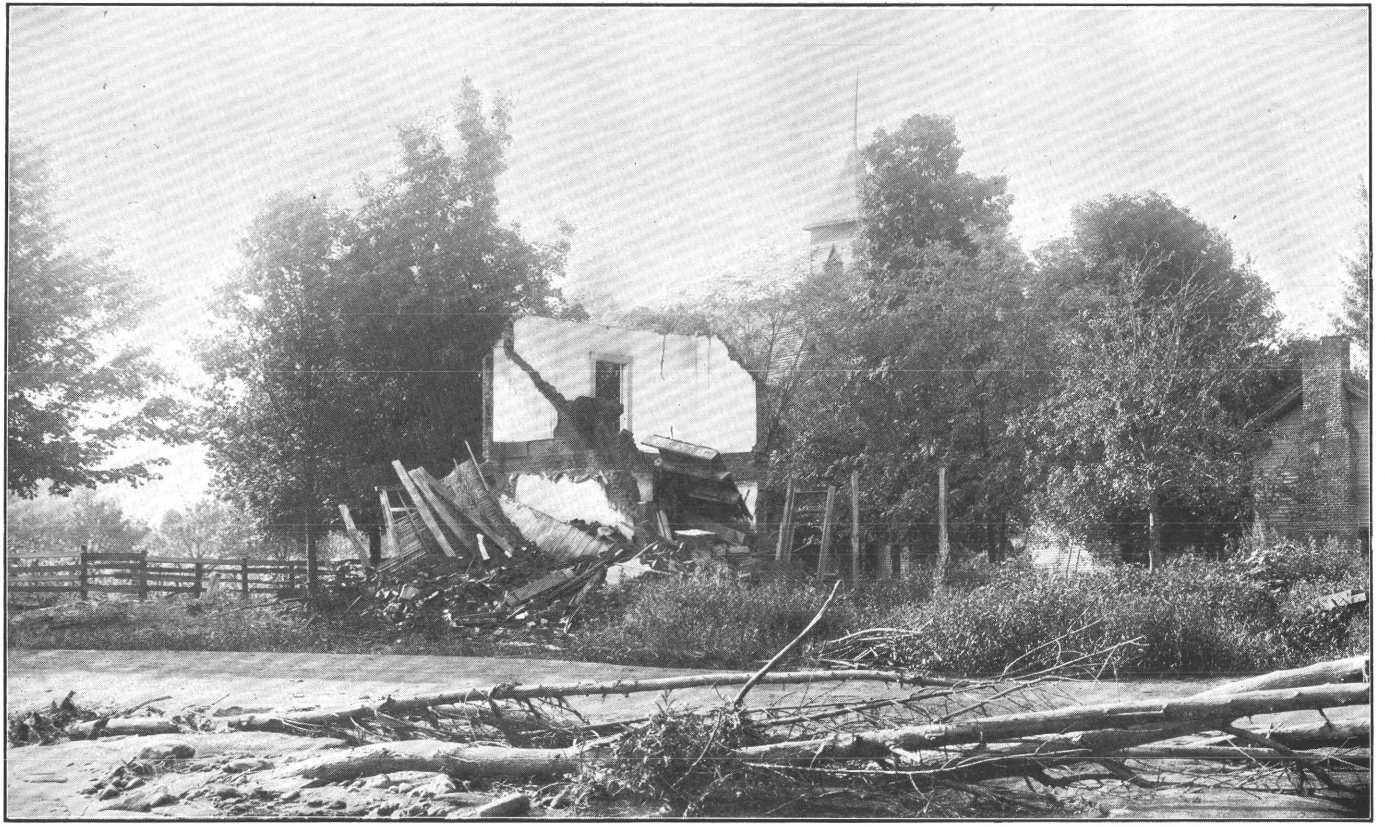
A very large part of the basin is still covered with the original forest. It is estimated that of the 640 square miles in North Carolina 78 per cent is forested, owing, doubtless, to the inaccessibility of the country. It is thought, however, that deforestation will begin in the near future, since in the summer of 1900 the Ohio River and Charleston Railroad was completed as far as the mouth of Caney River, and it is probable that the area drained by that stream will be lumbered at once, as already small spasmodic efforts in that direction have been made. Small sawmills run by water power have been built on a number of the smaller tributaries, and in a few instances splash dams have been constructed for the purpose of driving the logs over the rocky ledges of the mountain streams. Pl. XXIX, *A*, shows a splash dam on Little River, Tennessee, which raises the water 35 feet. Pl. XXIX, *B*, shows a characteristic combined sawmill and gristmill of Yancey County, with its immense overshot wheel.

MINERALS.

The area is very rich in minerals, Mitchell and Yancey counties, as already stated, furnishing a large part of the world's supply of mica. Many varieties of gems also occur, such as emerald, aquamarine,



GORGE OF NOLICHUCKY RIVER.



VIEW SHOWING EFFECT OF FLOODS ON NOLICHUCKY RIVER.

amethyst, and tourmaline. Some corundum has been found, and there are large deposits of iron ore, notably in the small stream valley of Bumpass Cove, where the iron is mined to supply the furnace at Embreville, which has a capacity of 150 tons of pig iron a day.

DISCHARGE MEASUREMENTS.

During the investigation a temporary gaging station was established on the Nolichucky near Chucky Valley, Tenn., where gage-height readings were maintained and measurements were made as shown in the following table. The river was also gaged near Erwin, Tenn., and numerous miscellaneous measurements were made on its tributaries, as shown by the table on pages 108 and 109.

Discharge measurements of Nolichucky River.

Date.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.			*Feet.*	*Sec.-ft.*
Sept. 5	Near Chucky Valley, Tenn	L. V. Branch and E. W. Myers.	2.0	302
Sept. 20	do	do	2.18	442
Oct. 15	do	do	2.0	378
Nov. 10	do	do	2.9	919
Aug. 23	Near Erwin, Tenn	L. V. Branch	20.67	770
Sept. 4	do	do	21.53	411

NOTE.—At regular stations of the Geological Survey gages are installed by which the rise of the river is measured, an increase in the gage height representing an increase in the discharge of the stream. This is true of the measurements in the above table which were made near Chucky Valley. In making the measurements near Erwin, however, bench marks were established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. In the latter cases, therefore, an increase in the gage height means a lowering of the water surface and a corresponding decrease in the discharge of the stream.

WATER POWERS.

The fall of the river is very much less than would naturally be expected in a stream draining so high and mountainous an area, the total fall between the junction of the North and South Toe and Embreville being only about 850 feet in a distance, following the course of the river, of about 40 miles, an average of about 21 feet to the mile. Throughout this part of its course the river flows through a gorge with steep and rocky sides, and although there are numerous places where dams could be constructed, and although the fall per mile is large, the opportunities for developing the power are meager, for building room is lacking and the construction of raceways would be costly. Good railroad facilities exist here, since an extension of the Ohio River and Charleston Railroad passes along the river bank.

About 1½ miles below the mouth of Caney River, where the stream is about 200 feet wide, there is a fall of 25 feet, or a little more, in a distance of a half mile, but as elsewhere throughout this portion of its course, there is no building room close to the river, though sites could be found near the summits of the hills.

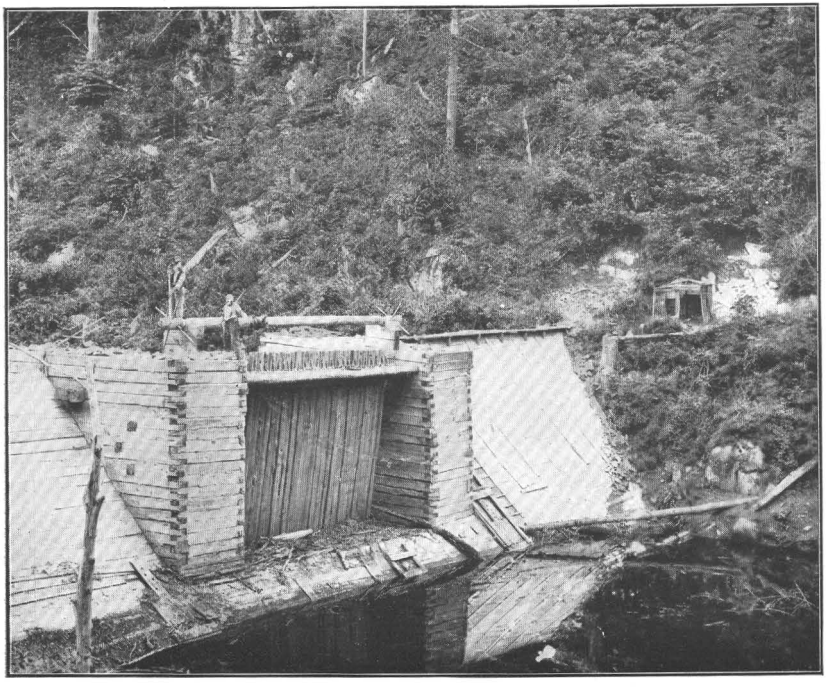
TRIBUTARIES OF NOLICHUCKY RIVER.

DISCHARGE MEASUREMENTS.

The drainage basins of the principal tributaries of the Nolichucky down to Embreville, Tenn., were visited and the following measurements were made, in order upstream:

Discharge measurements of tributaries of Nolichucky River.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
1900.					
Aug. 22	Rock Creek	100 yards above mouth, Tennessee	L. V. Branch	3.69	6.37
Do	North Indian Creek.	Unicoi, Tenn	do	4.58	37.9
Do	do	Erwin, Tenn	do	3.95	51.0
Sept. 4	do	do	do	4.19	22.0
Sept. 19	do	do	E. W. Myers	4.05	29.7
Oct. 16	do	do	L. V. Branch	4.18	26.13
1901.					
June 18	do	do	E. W. Myers		174.0
1900.					
Aug. 23	Martin Creek	Near Erwin, Tenn	L. V. Branch	1.59	7.55
Sept. 4	do	do	do	1.68	6.45
Aug. 23	South Indian Creek.	do	do	5.38	52.3
Sept. 4	do	do	do	5.49	33.2
Sept. 19	do	do	E. W. Myers	5.40	53.0
Aug. 23	Hollow Poplar Creek.	Ford of Erwin-Bakersville road, North Carolina.	L. V. Branch	8.15	5.98
Oct. 16	do	do	do	8.26	2.61
Aug. 24	Toe River	Near Huntdale, N. C	do	15.89	381.0
Oct. 17	do	do	do	16.12	301.0
Aug. 27	North Toe River	At ford of Linville-Cranberry road, North Carolina.	do	3.60	18.0
Do	do	Plumtree, N. C	do	7.55	79.0
July 2	do	Near Sprucepine, N. C	H. A. Pressey		323.0
Aug. 26	do	do	L. V. Branch	18.20	105.0
Oct. 21	do	do	do	18.37	78.0
Oct. 25	do	do	do	17.15	570.0
Aug. 24	Pigeon Roost Creek.	At mouth, North Carolina	do	7.39	14.5
Oct. 19	do	do	do	7.47	4.12
Aug. 24	Big Rock Creek	Ford of Huntdale-Bakersville road, North Carolina.	do	2.42	51.3
Oct. 19	do	do	do	2.64	24.5
Sept. 3	Jack Creek	At mouth, North Carolina	do	6.09	8.71
Oct. 19	do	do	do	6.10	6.83
Sept. 3	Pigeon Creek	do	do	5.86	1.65
Oct. 19	do	do	do	5.85	1.26
Aug. 24	Cane Creek	One-half mile above mouth, North Carolina.	do	9.20	11.78
Oct. 19	do	do	do	9.26	9.92
1901.					
Oct. 21	do	Bakersville, N. C	E. W. Myers		22.82
Oct. 22	do	do	do	0.99	21.05
1900.					
Aug. 25	Brush Creek	Lower ford of Burnsville-Sprucepine road, North Carolina.	L. V. Branch	1.39	4.37
Oct. 20	do	do	do	1.51	0.72
Aug. 25	Crabtree Creek	Ford of Burnsville-Sprucepine road, North Carolina.	do	7.97	15.2
Oct. 20	do	do	do	7.91	14.55
Aug. 25	Snow Creek	Wing, N. C	do	3.03	2.0
Aug. 26	Bear Creek	Flatrock, N. C	do	3.76	4.67
Oct. 20	do	do	do	3.70	3.73
Aug. 26	Grassy Creek	Sprucepine, N. C	do	5.21	6.09
Oct. 20	do	do	do	5.13	9.15
Aug. 26	Beaver Creek	Near Sprucepine, N. C	do	4.50	3.29
Oct. 21	do	do	do	4.29	3.08
Aug. 26	Threemile Creek	Near old post-office at Elsie, N. C	do	5.38	2.63
Oct. 21	do	do	do	5.30	3.57



A. SPLASH DAM ON LITTLE RIVER, TENNESSEE.

B. COMBINED SAWMILL AND GRISTMILL ON PRICE CREEK, YANCEY COUNTY, N. C.

Discharge measurements of tributaries of Nolichucky River—Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
Aug. 27	Hensons Creek	At mouth, North Carolina	L. V. Branch	6.94	4.8
Do	Plumtree Creek	Plumtree, N. C	do	2.99	8.09
Do	Roaring Creek	At mouth, North Carolina	do	7.89	15.57
Do	Squirrel Creek	One-fourth mile above mouth, North Carolina.	do	3.12	11.2
Aug. 28	Horse Creek	At mouth, North Carolina	E. Graves	5.55	9.03
Oct. 24	do	do	L. V. Branch	5.15	40.53
Aug. 27	Whiteoak Creek	do	do	2.26	3.36
Do	Kentucky Fork of North Toe River.	do	do	2.85	9.7
Aug. 31	South Toe River	One mile above mouth of Three Fork Creek, North Carolina.	do	4.34	26.0
Oct. 26	do	do	do	3.30	101.0
July 1	do	Ford of Micaville-Sprucepine road, North Carolina.	H. A. Pressey		220.8
Aug. 25	do	do	L. V. Branch	8.08	79.8
Aug. 30	do	do	do	7.98	86.23
Oct. 27	do	do	do	7.23	282.9
Aug. 30	Cane Branch	Ford of Micaville-Marion road, North Carolina.	do	3.92	2.98
Oct. 26	do	do	do	3.78	8.59
Aug. 30	Little Crabtree Creek.	Just above lower ford of Micaville-Sprucepine road, North Carolina.	do	4.28	17.54
Oct. 27	do	do	do	4.23	21.67
Aug. 30	Brown Creek	Ford of Micaville-Marion road, North Carolina.	do	3.02	4.94
Oct. 26	do	do	do	2.85	9.43
Aug. 30	Whiteoak Creek	At mouth, North Carolina	do	4.66	4.40
Oct. 26	do	do	do	4.28	19.86
Aug. 30	Locust Creek	do	do	1.98	3.83
Oct. 26	do	do	do	1.87	7.96
Aug. 31	Colbert Creek	Ford of Micaville-Marion road, North Carolina.	do	3.87	2.51
Oct. 26	do	do	do	3.50	7.24
Aug. 31	Middle Creek	do	do	3.94	3.78
Oct. 26	do	do	do	3.64	9.20
Aug. 31	Rock Creek	do	do	1.96	6.92
Oct. 26	do	do	do	1.62	28.68
Aug. 31	Three Fork Creek.	One-fourth mile above mouth, North Carolina.	do	1.49	9.49
Sept. 1	Caney River	Near Big Tom Wilson's, North Carolina.	do	1.33	17.11
Oct. 18	do	do	do	1.34	13.9
Aug. 24	do	Huntdale, N. C	do	3.69	89.9
Sept. 3	do	do	do	3.82	62.77
Oct. 17	do	do	do	3.83	58.3
Sept. 2	Big Creek	At mouth, North Carolina	do	2.83	5.67
Oct. 17	do	do	do	2.89	2.0
Sept. 2	Little Bald Mountain Creek.	do	do	4.91	2.12
Oct. 17	do	do	do	4.90	2.61
Sept. 2	Bald Mountain Creek.	One mile above mouth, North Carolina.	do	3.43	19.7
Oct. 17	do	do	do	3.55	10.6
Sept. 2	Elk Shoal Creek	At mouth, North Carolina	do	1.63	1.29
Do	Bald Creek	Near Burnsville, N. C	do	4.56	16.25
Oct. 18	do	do	do	4.56	9.97
Sept. 2	Price Creek	do	do	2.48	9.46
Oct. 18	do	do	do	2.53	8.35
Sept. 1	Bowlems Creek	do	do	5.03	3.45
Oct. 18	do	do	do	4.97	4.02
Sept. 1	Cattail Branch	do	do	2.78	2.77
Oct. 18	do	do	do	2.64	4.69
Sept. 1	Elk Fork Creek	Near Big Tom Wilson's, North Carolina.	do	1.24	4.78
Oct. 18	do	do	do	1.28	1.49

NOTE.—In making the measurements recorded in the above table bench marks were established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. An increase in the gage height, therefore, means a lowering of the water surface and a corresponding decrease in the discharge of the stream, the reverse of the results at the regular stations of the Survey, where gages are installed and where an increase in the gage height represents an increase in the discharge of the stream.

Descriptions of the drainage basins and water powers of the larger of these tributary streams are given on the following pages, in order upstream.

NORTH INDIAN CREEK.

Around Erwin, Tenn., and up North Indian Creek there is a very picturesque farming country. The creek drains a large area, the upper part of which is mountainous, with steep slopes, while near the Nolichucky it broadens out into a fertile valley. The low-water discharge was measured and found to be 22 second-feet. On this creek, at Unicoi, Tenn., the Unaka Milling and Lumber Company has a large wood-working plant and gristmill. Their power (about 40 horsepower) is developed by 20-inch and 24-inch turbines working under a head of 16 feet. Just above Unicoi an old ore washer formerly utilized a fall of 30 feet, but it is now out of use. On Dick Creek, a tributary of North Indian Creek, there are four falls averaging 30 to 40 feet each. In the limestone cove on North Indian Creek there are four gristmills using the water power. This cove is a widening of the valley of the creek, and in it are a number of good farms under cultivation. Much limestone is found over this entire section of country. Two miles above Erwin, on the Nolichucky, J. T. Wilder has a sawmill and wood-working plant. The dam across the stream is 17 feet high and backs the water in the river three-fourths of a mile. About 80 horsepower is developed by one turbine.

SOUTH INDIAN CREEK.

Entering the river from the south, about 2 miles above Erwin, is South Indian Creek, a stream in many respects similar to North Indian Creek, though the proportion of cleared land in its basin is somewhat less.

The creek rises on the northern slope of the Unaka Mountains, draining an area the upper part of which is made up of high, steep, and rugged mountain slopes, which as a rule are very densely forested. As the stream is descended, however, the mountains recede from it and leave broad and fertile bottoms, which are entirely cleared and under cultivation, grass, corn, and wheat being the principal crops. The cleared areas form a very small part of the whole basin, however, probably less than 10 per cent.

A great deal of timber is being cut in this area, particularly near the heads of the smaller tributaries near its mouth, and there are several small sawmills located on the creek which cut part of this product, the remainder being worked upon the spot by the small portable sawmills which are moved from place to place as the timber is cut.

At the time the stream was visited in September, 1900, its discharge was very low—about 33 second-feet. It is said to have reached a lower stage during the summer and fall of that year than ever before. The flood rise at the mouth is between 7 and 8 feet.

HOLLOW POPLAR CREEK.

This stream, which receives its drainage from the eastern slope of the Unaka Mountains, has a low-water flow of about 6 second-feet. Excepting the lower 2 miles, where there are several small farms, the creek valley is very narrow, with almost no land under cultivation. The side hills are steep and are heavily covered with timber and underbrush. The slope is greater than that of either North Indian Creek or South Indian Creek, the total fall from source to mouth, a distance of 5 miles, being about 2,000 feet. The fall is greatest near the headwaters, where it is a mountain stream jumping from ledge to ledge down the side of the mountain. There is no cleared land except near its mouth, the steep slopes being covered with the original forest growth.

NORTH TOE RIVER.

The North Toe rises on the western slope of the Blue Ridge, in the northeastern part of Mitchell County. Its course is circuitous, flowing first to the southwest, then to the west, and then to the northwest, receiving numerous tributaries, the chief of which is the South Toe, which unites with it on the line between Mitchell and Yancey counties. Practically the whole of Mitchell County is drained by the North Toe and its tributaries, the Nolichucky proper receiving the drainage from the extreme western part of the county, a small part of the northeastern section draining into Elk Creek, a tributary of the Watauga, and another small portion of the eastern section being drained by Linville River.

The region of the headwaters of the North Toe is very rough, with steep mountain slopes and narrow valleys sparsely populated. Along Whiteoak Creek and for a distance on the main stream and the Kentucky Fork above their junction the valley is wide and flat, but is heavily timbered. Part of it is in a rather swampy condition and is covered with heavy laurel thickets. Below the mouth of Whiteoak Creek the mountains close in and form a narrow and steep gorge as far down as Horse Creek. There the valley widens out a little, and from there down there is some bottom land under cultivation on each side of the river.

The tributaries of the river in this section and as far down as Sprucepine flow directly from the mountains in narrow gorges. They are for the most part short streams with great fall but with little water. The only cleared land along them is within a half mile of their mouths or on top of the mountains from which they flow, the mountain sides being too steep for successful cultivation. Throughout the region from the head of the river and its tributaries down to Sprucepine and to the mountain summits on either side probably not more than one-sixth of the land is cleared. The cleared areas are

nearly all planted in wheat and corn, although a small portion is in grass, for grazing purposes. A few miles above Sprucepine the mountains recede from the river, leaving a very wide valley, which extends down to the Cane Creek Valley on the north side of the river and to Caney River on the south side. This valley is rather hilly throughout most of its area, and the land is cleared on the north side between Sprucepine and Bakersville. On the south side most of the cleared land is around Burnsville, although there are a number of farms near Sprucepine and along Grassy Creek.

One mile above the mouth of Pigeon Roost Creek and just above the ford there is a very good site for the construction of a dam. A water power of considerable magnitude could be developed here. Lying to the south of the main channel of the river is an island which rises about 15 feet above the water level and is never overflowed, not even during the highest floods. There is a heavy fall in the river, and by the construction of a dam from the end of the island to the north bank of the stream all of the water could be turned into the narrow channel behind the island and a fall of 15 feet or more be obtained.

Above this point there are many shoals, the river having a large fall throughout that part of its course, flowing in a deep gorge, with sides rising at angles of 30 to 40 degrees. There are several small mills on the upper part of the river, but the larger portion of the power developed in the basin is derived from the tributaries, the needs of the mills requiring the development of only a few horsepower at any place. Powers of considerable magnitude, however, can be developed on these streams, for notwithstanding the amount of water carried by each one is small the fall obtainable in a short distance is large, and absolutely safe locations for buildings can be obtained, which is not always the case on the main river.

The first mill of any size on the North Toe is just above the mouth of Bear Creek. It is a gristmill, mica-grinding mill, and wood-carving establishment. The owners have developed a 6-foot fall and claim to have about 75 horsepower. At Elsie, farther upstream, there is a combined flour mill, sawmill, and gristmill with a small dam giving a 10-foot fall.

Just below the mouth of Plumtree Creek Vance Brothers have a combined mica mill and sawmill, using a large part of the low-water flow in the river with a 36-inch Samson turbine under an 11-foot head. Mica is abundant throughout this district, and is mined extensively from Plumtree Creek down the river as far as Big Rock Creek on the north and Caney River on the south. In this district there are also several water powers developed for grinding mica.

The swift-flowing tributary streams of the North Toe, with their numerous vertical falls, furnish abundant power for small mills, and a number of the power sites have been developed, though in a small way.

On Pigeon Roost Creek, which enters Toe River 2 miles above the mouth of Caney River and has a low-water flow of about 14½ second-feet, there are two large mills, the first a small sawmill and gristmill about 100 yards above its mouth, utilizing a fall of 16 feet; the second one a sawmill and gristmill 3 miles upstream, using an overshot wheel.

There are only two rolling mills in Mitchell County—one on Big Rock Creek, belonging to Henry Master and having a capacity of 30 barrels per day; the other on Cane Creek, just below Bakersville, and having about the same capacity. At Magnetic, on Big Rock Creek, there is a large mica mill, and at the mouth of Beams Creek is located Garland's mica mill, using a 15½-inch Leffel wheel. On Cane Creek there is a sawmill just above its mouth, and at Wing, on Snow Creek, J. C. Phillips has a sawmill and gristmill using two overshot wheels of 14 and 15 feet diameter, respectively. Above this mill there are two small gristmills on Snow Creek.

On Crabtree Creek, 4 miles above the mouth, there is a fall of 100 feet, 40 feet of which is in a clear vertical leap. Six mica mills, run by one turbine under 116 feet head, are located at this place. On Bear Creek there are two small corn mills with a fall of 20 feet and 12 feet, respectively. On Beaver Creek there is a combined sawmill and corn and wheat mill run by an overshot wheel and a Leffel turbine with an 18-foot fall. Farther up the stream there is a small corn mill run by a 16-foot overshot wheel.

On Hensons Creek (marked Powdermill Creek on atlas sheet—an obvious error, for Powdermill Creek is the unnamed tributary just above it) there are three mills. The lower one is a small gristmill run by a tub wheel. Above this is Houston's sawmill, gristmill, and planing mill, run by a Leffel wheel under a 35-foot head. The upper mill, Green's sawmill, has an overshot wheel and 23 feet fall. On Plumtree Creek there is a mill, run by using the 12-foot fall on a turbine wheel, making pins for telegraph wires. One mile above, on the same creek, there is a mica mill using 91 feet fall on a turbine. Still higher up on Plumtree Creek there are four small corn mills. Powdermill Creek, Hensons Creek, Roaring Creek, and Squirrel Creek, running down the sides of the mountain, have almost unlimited falls but little water. The discharge of these streams at their lowest stages is as follows: Hensons Creek, 4.8 second-feet; Powdermill Creek, barely 1 second-foot; Roaring Creek, 16 second-feet; and Squirrel Creek, 11 second-feet.

By far the largest tributary of the North Toe is Big Rock Creek, which with its tributary Little Rock Creek rises on the southern slope of the Iron Mountains, which form the dividing line between Tennessee and North Carolina. They receive a large part of the drainage from those high and rugged mountains, the culminating peak of which is Roan High Knob, with an elevation of 6,313 feet. Cloudland, a noted summer resort on this peak, affords one of the finest

views obtainable from any of the summits of the Appalachian Mountains. Here is a very comfortable summer hotel, pure water, cool climate, and all that goes to make a pleasant and healthful summer resort. A narrow-gage railroad passes through Roan Mountain Station, 12 miles from Roan High Knob, from which point a good road has been built up the mountain side. When on Roan Mountain the Black Mountains, Hawks Bill, Table Rock (on Linville River), and the mountains of Virginia and Tennessee are in full view. One can but wonder why more is not known of these mountains and why the visitors are so few. It is, however, probably a matter of only a few years before this region will be one of the great mountain resorts of the country.

SOUTH TOE RIVER.

This river rises in the southern part of Yancey County, N. C., and flows directly north into the North Toe. It receives its drainage from the eastern slope of the Black Mountains and the western slope of Sevenmile Ridge. It follows close to the base of the latter ridge, which rises abruptly from the water's edge. On the west side of the stream the steeper slopes of the Black Mountains are about 2 miles from the river, leaving a narrow valley between. There are, however, no farms on either side of the stream, and even in the narrow valley on the west side only a few tracts (hardly one-fifth of the area) have been cleared for cultivation. Considering the drainage basin from the river to the mountain summits on both sides, probably not 1 per cent of the land has been cleared. About 2 miles above the mouth of the river the mountains on both sides recede, leaving the land from that point to the North Toe level compared with the rest of the region, although it is still a very hilly country.

Little Crabtree Creek, with a minimum discharge of 18 second-feet, is the largest tributary of the South Toe. It rises near Burnsville, in the foothills of the mountains, and joins the river a short distance northeast of Micaville. The river has seven other small tributaries, ranging in size from 2.5 to 9.5 second-feet at their lowest mid-summer flow.

There is not a mill on the South Toe, and only one or two small corn mills on its tributaries. The steep watershed and the short tributaries carry the rainfall quickly to the main stream, causing rapid fluctuations and high floods, making mill improvements difficult and expensive. This probably accounts for the few power developments in the watershed.

CANEY RIVER.

This river also rises in the southern part of Yancey County and flows northward uniting with Toe River to form the Nolichucky. It receives its drainage from the western slopes of the Black Mountains

and the eastern slopes of the Bald Mountains, and has a minimum discharge of about 63 second-feet from a drainage area of about 158 square miles. The western slopes of the Black Mountains are similar to the eastern slopes, which are drained by the South Toe, being steep and heavily wooded, the forest growth changing from the foot to near the top, where little except balsam is able to stand the low temperature. Near the foot of the mountains large areas are covered with heavy laurel thickets.

Unlike the South Toe, most of the cleared land along Caney River is in its upper and middle portions, while along its lower course the stream flows through a valley so narrow that it may be considered almost a gorge. The valley above Burnsville, however, is wider than that of the South Toe and has a larger percentage of cleared land. One mile below Burnsville the river enters a narrow gorge through which it runs for about 3 miles, but even here the higher lands are largely cleared. Farther down, the country is flat and well cleared for 6 or 7 miles; then the river enters the narrow gorgelike valley through which it flows, with many twists and turns, around the mountain knobs to its mouth. In this gorge there are very few places wide enough for clearing, but on the mountain sides the land is cleared except in the steepest parts. During the last summer (1900) the Ohio River and Charleston Railroad was extended up Nolichucky River as far as the mouth of Caney River, and since that time much lumbering has been done in this section, as already mentioned. Of the area drained by Caney River perhaps one-fourth is cleared. Fully one-half of the valley land is cleared and is largely under cultivation. Wheat and corn are the principal crops. Near the head of the valley lives Big Tom Wilson, one of the earliest settlers in this region and the man who found Professor Mitchell after his ill-fated expedition and untimely death.

The only tributaries of Caney River of any size are Bald Creek, which has a low-water flow of 16 second-feet, and Bald Mountain Creek, which has a low-water flow of 20 second-feet. There are other smaller tributaries, ranging in their low-water discharge between 1.3 and 9.5 second-feet.

Only one water power on Caney River has been developed, and this by a small gristmill located about halfway between Burnsville and the mouth of the river. A large tract of land at the headwaters, including the northwestern slope of Mount Mitchell, is owned by Colonel Murchison, of New York, who holds it as a game preserve.

FRENCH BROAD RIVER.

GENERAL FEATURES.

French Broad River rises on the eastern slope of the Tennessee Ridge, between Jackson and Transylvania counties, N. C., flows in a general northeasterly direction across Transylvania and Henderson

counties, a distance of about 30 miles, then northward across Buncombe County, a distance of more than 20 miles, then northwesterly across Madison County, a distance of 20 miles, through the Great Smoky Mountains and into eastern Tennessee, where it is joined by the Nolichucky and the Holston, and finally enters Tennessee River, its waters eventually reaching the Mississippi and the Gulf of Mexico. For convenience the drainage basin has been divided into two parts: (1) The area drained by the river in North Carolina, and (2) the area drained by it in Tennessee.

WATERSHED IN NORTH CAROLINA.

The portion of the drainage basin of French Broad River in North Carolina is comprised within the limits of Transylvania, Henderson, Buncombe, and Madison counties. The small streams from the mountains in the upper part of the watershed soon reach the wide plateau and unite into a broad and sluggish river, with practically no shoals or falls. Little clearing has been done on the upper watershed, but an extension of the Transylvania Railroad has just been completed as far as Jeptha, for the purpose of transporting lumber. The terminus of this extension is called Toxaway. The larger part of the land around the headwaters of the main stream as far as the North Fork is owned by the Toxaway Company, and they expect very soon to commence extensive lumbering operations.

Through all of this region springs are numerous, and the water is pure and cold. Above Jeptha there is very little pasture land, but the region appears to be well adapted to grazing. The mountains around the head of the North Fork are high, many of them reaching an elevation of 6,000 feet. They are traversed by trails only, the forests being still in a wild condition and the region but sparsely populated. The watershed of the North Fork as a whole is not thickly wooded, but no timber cutting has been going on for a long time. Most of the land east of this stream, including the large area of Pisgah Ridge, is owned by Mr. George W. Vanderbilt and is under the care of an expert forester. Above Jeptha the mountains close in to the banks of the stream, and consequently the branches are short and the slopes steep. Between the mouth of Tucker and Shoal creeks, on the North Fork, are some excellent shoals, but no suitable locations for large buildings, although there are shelves of rock on each bank throughout the entire distance. The fall here is about 30 feet in 200, consisting of three drops about 100 yards apart, with rapids intervening. The water power has not yet been utilized.

The drainage area of the river above Asheville is 987 square miles; the total drainage area in North Carolina 1,745 square miles. Of this total area at the time the Tenth Census was taken 1,091,000 acres were under cultivation and 8,079,000 acres, or 78 per cent of the whole, were still forest covered. In 1890, according to information

gathered for the Eleventh Census, about 30 per cent of the area was cultivated land, and as the rate of clearing has been accelerated during the last decade, on account of the large development of the lumber industries, it seems safe to conclude that at the present time about 40 per cent of the whole area is either cultivated land or land from which the timber has been removed.

Transylvania County, in which are the headwaters of the river, is a true mountain region, having on its southern boundary the Blue Ridge in its most massive and imposing form, and being the starting point of the great Pisgah and Balsam ranges, which stretch through the county toward the north. The only exceptions to the rugged topography are the broad and fertile valleys of the French Broad and its tributaries, which are cultivated and in a high state of improvement, being among the most valuable and productive farming lands in the State. These valleys are the scene of an important stock-raising industry, which is the principal source of revenue, though enormous crops of cereals and grasses are produced, some tobacco is raised, and fruits of large size and fine flavor are grown. The greater part of the county is still in the original forest growth of the usual varieties found in these mountains, which attain great size on account of the surpassing fertility of the soil. There are extensive areas of white-pine timber which will yield fairly good lumber. The merchantable trees of walnut and cherry have been largely removed, though an occasional walnut of fair size is seen, and small tracts of cherry are said to exist on the higher mountain slopes. Large tracts of poplar are also to be found, and but little oak has been cut. It is estimated that of the total area of the county only about 15 per cent is cleared land.

There has been no development whatever of the mineral wealth of Transylvania County, though gold, silver, lead, copper, nickel, asbestos, corundum, and mica are said to exist in the vast wilderness of the Balsam and the Pisgah mountains.

Henderson County is the northward or downstream continuation of the valley of the French Broad, and its topographic features are similar to those of Transylvania County, except that its areas of comparatively level and fertile land are larger and the general aspect of the country is less mountainous. A remarkable feature is the apparent great depression of the surface and the width of the stream valleys, some of which assume, as on Mud Creek, the character of a wide swamp. This depression is, however, apparent and not real, the most depressed portions being above the level of the Blue Ridge plateau. The hillside slopes are very gentle.

The soil on the uplands is not remarkably fertile, being a light-gray gravelly or sandy loam. The soil in the valleys is in large part alluvial, with much vegetable matter, and yields large crops of grains, grasses, vegetables, and fruits. Corn grows well, especially in the valleys, but the principal agricultural industry is the production of

cabbages and other vegetables for market. A great deal of fruit is also grown, and is either canned or dried.

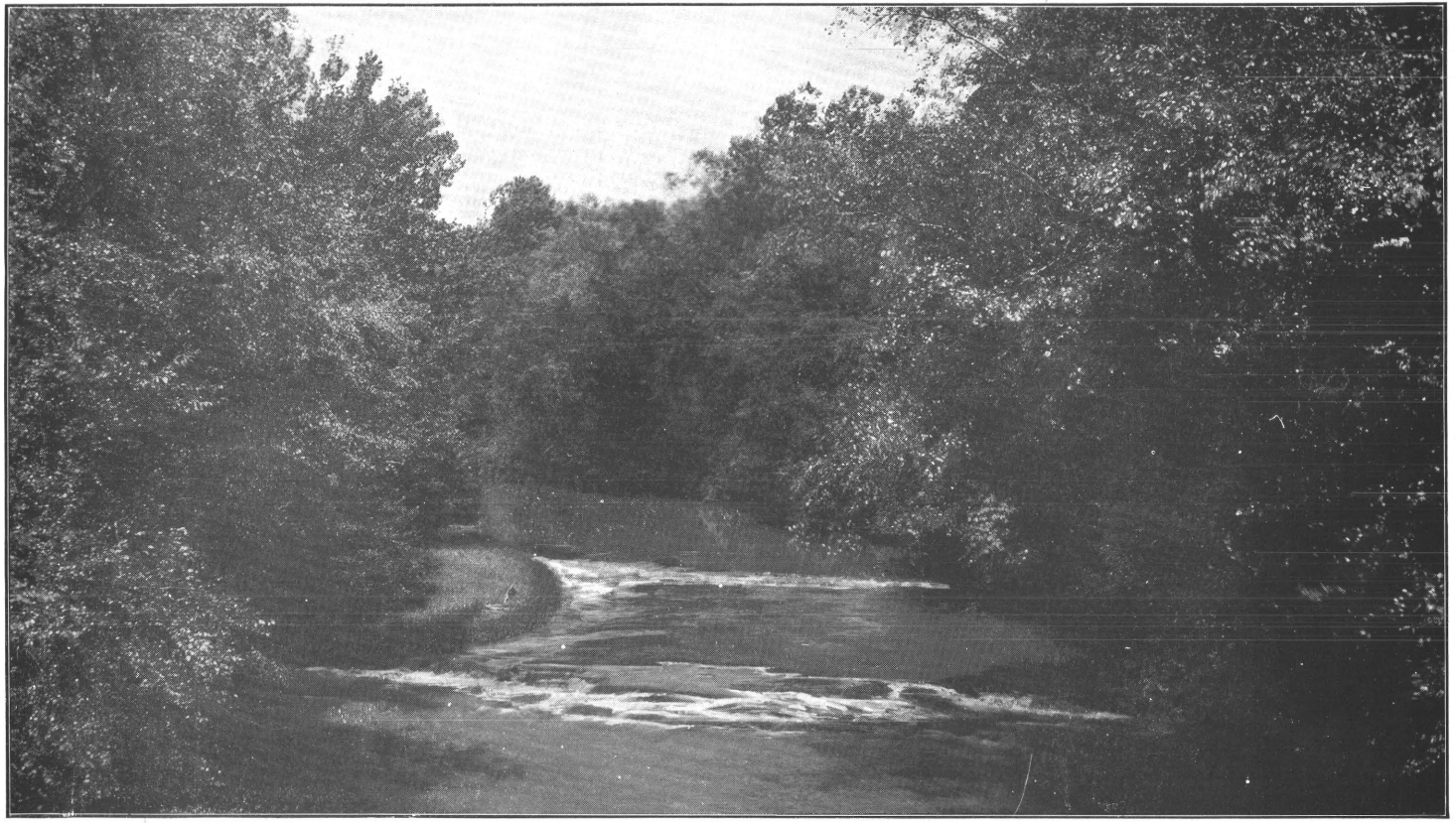
Along the stream valleys of Henderson County pine is the predominant growth, but on the uplands oak, chestnut, hemlock, and pine are to be found, while near the summit of the mountains and in the cold and sheltered coves walnut, cherry, maple, and an occasional white pine are seen. The lumber industry, however, is of small importance, though some logs have been floated to Asheville, and small amounts of timber are cut annually for local uses. Some tan bark is also gathered.

Although the proportion of comparatively level land in this county is very great, a smaller proportion of the area is cleared than in either Madison County or Buncombe County, the cleared land amounting to about 31 per cent of the whole, according to the returns of the Eleventh Census, and only small amounts of clearing have been done since that time, so that it is improbable that the cleared land now amounts to more than 35 per cent of the entire area.

The country rock throughout Henderson County is for the most part a gneiss, but the valley of Boylston Creek is in a schistose limestone of a gray-blue color, which in places carries thin veins of quartz. The mineral wealth of the county is greater than that of either Madison County or Buncombe County. What is said to be the largest deposit of zircon in the United States occurs in the valley of Green River, and gold is found at the Boylston mine, on the southeastern slope of Forge Mountain, 13 miles west of Hendersonville.

The general surface of Buncombe County, the next county to the north, is more hilly than mountainous, with stream valleys narrow and limited in extent, which, however, offer good facilities for agricultural operations. Between Asheville and Alexander the country on the north side of the river as far as could be seen was gently rolling, with slopes of from 5 to 15 degrees, about two-thirds cleared and largely cultivated in grass. On the south side of the stream the country preserves the same general character, but the hillside slopes appear gentler, averaging between 5 and 10 degrees, about the same proportion of land being cleared. The forest growth, which for several miles back from the stream is in small segregated areas—too small to affect the run-off—is more largely pine than in the basins heretofore described. A number of tributaries rising in the gaps of the mountains enter the main stream, adding much to the beauty of the scenery. Every year great numbers of tourists visit the valley of the French Broad in search of health or pleasure. Pl. XXX is a view on Swannanoa River, one of the favorite streams of nature-loving tourists.

The upland soils in Buncombe County are stiff, even-grained loams, rarely sandy, generally deep, being derived from the disintegration *in situ* of gneiss, and are on the whole very fertile. The soils on the lowlands are rich sedimentary loams, with much vegetable matter



SWANNANOA RAPIDS ON SWANNANOA RIVER, NORTH CAROLINA.

along the smaller streams. Along the larger streams are loams similar in character to those on the smaller streams, but more sandy and less fertile. The hills erode rapidly when unprotected, but are generally quickly seeded with grass, producing a retentive turf.

The soils produce all of the cereals, grasses, and fruits, wheat yielding 10 or more bushels to the acre. Oats do well. Corn thrives, producing from 30 to 40 bushels to the acre, while clover and the grasses yield fine crops of hay. In recent years more and more attention has been paid to the raising of beef cattle for market, and this is now an important industry throughout the county. Many chickens and turkeys are also raised, these selling for good prices. Of the fruits, apples are produced in greater abundance than any other, and they are of large size and fine flavor. All vegetables grow well, the cabbages being particularly good. Tobacco is largely cultivated along the river and on the hills a few miles back from it, these localities seeming best adapted to its production. A good grade of bright tobacco is obtained.

The timber in Buncombe County includes all of the varieties found in the mountains—oak, hickory, walnut, beech, birch, chestnut, locust, pine, spruce, and others, with a dense undergrowth of dogwood, laurel, azalea, and other shrubs. There are large mills sawing lumber at Asheville and many small ones in close proximity to the timber. A considerable quantity of tan bark is also shipped from the county, the oak stocks being generally sold for fuel after being barked, but as a rule no use is made of the hemlock stocks. Walnut, curly birch, and curly ash are shipped in the log to veneering factories, but the merchantable trees of this class have been largely removed, and poplar and cucumber trees, which furnish the chief building materials of the region, are also becoming scarce. Timber that can be floated, such as pine, poplar, and chestnut, has been largely removed to supply the mills at Asheville, but little oak has been cut. According to the returns of the Eleventh Census, about 25 per cent of the area of the county was at that time cleared land. Since then, however, much clearing has been done, so that it is estimated that at the present time 40 per cent of the area is cleared; some estimates place the amount of cleared land at 50 per cent, and it is generally stated that about two-thirds of the cultivable land is cleared. Mr. George W. Vanderbilt is the largest owner of forest lands in the county. He owns many thousand acres to the south and east of Asheville, and modern scientific methods of forest management have been inaugurated in all forests owned by him.

As has previously been stated, the country rock of Buncombe County is principally a gneiss, though there are areas of granite, and across the southern edge of the county there is a narrow belt of slates and schists. The mining industry is unimportant. Talc is met with occasionally, nickel is seen in very small quantities, and a serpentine of good quality occurs in abundance between Weaverville and Leices-

ter, but the vein has never been worked. Magnetic iron ore has also been found at several places. It is said that many years ago some of the latter veins were worked; and a deposit has recently been opened at the Blackwell mine, near Blackwell Springs. Limonite is found in many places throughout the county, and brick clay is abundant. The latter is made into common and pressed brick at several yards, some fire brick is made, and a plant at Biltmore formerly manufactured drain and roofing tile and paving brick.

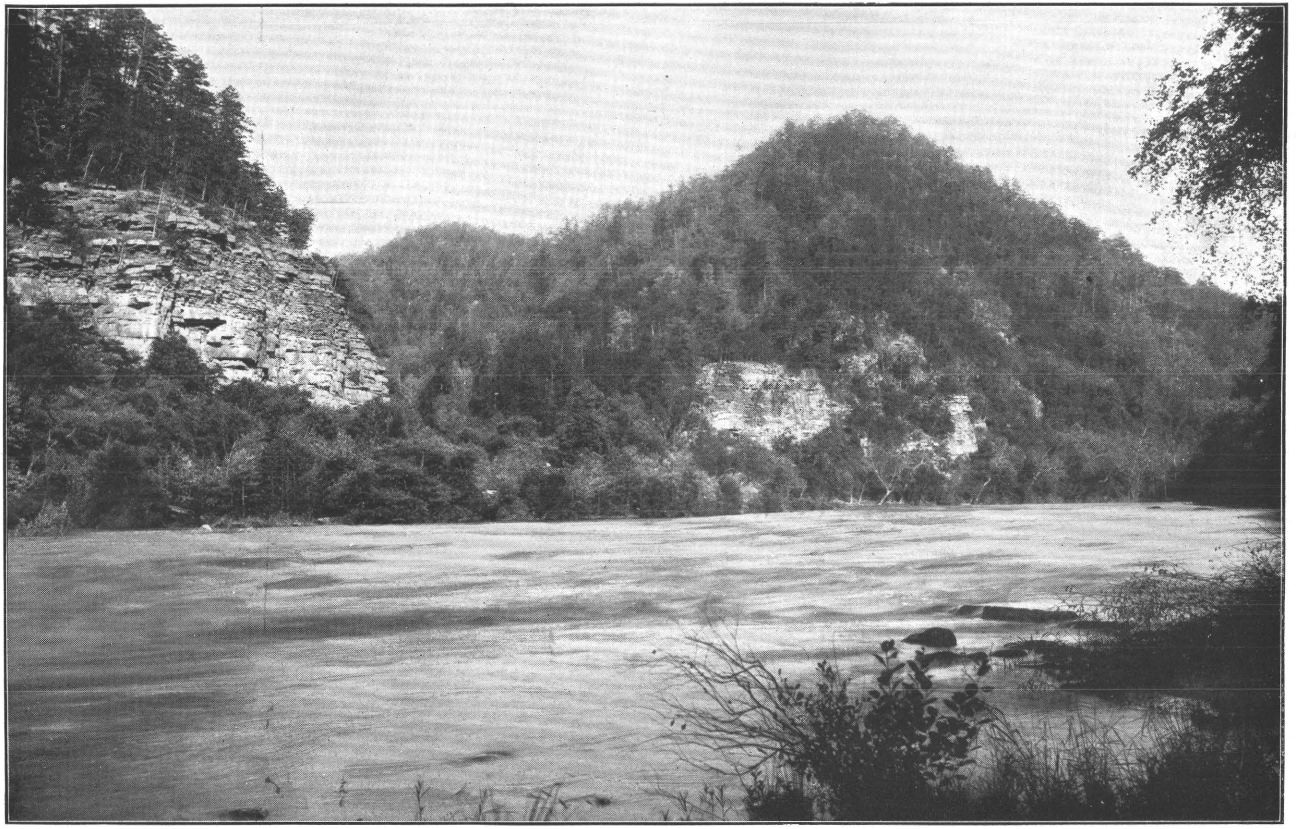
Mineral springs of divers kinds are abundant, those carrying sulphur being the most noted. There are also numerous nonmineral springs, which furnish large amounts of water to the streams.

The country roads furnish the chief means of transportation throughout the county, and while there has been a movement for good roads, particularly in the region near Asheville, the greater portion of the country roads are poorly graded and become almost impassable in the winter, on account of mud.

Madison County, the next county through which the French Broad flows, is also essentially a mountain country, there being very little valley land and the whole area being traversed by mountain ridges ranging in height from 2,500 feet to 4,500 feet above sea level. None of the ranges, however, rise to so great heights in this county as they attain in the adjoining counties, even the Great Smokies being below their average elevation. The soil is very fertile and produces fine crops, though from the almost entire absence of transportation facilities the agricultural products are limited to little more than enough to supply the inhabitants, a very small amount being raised for market. The hills are especially adapted to the production of a good grade of bright tobacco, large quantities of which were formerly grown and marketed in Marshall or Asheville, but recently, on account of the low prices obtained, this industry has suffered a diminution, and the "deadening," as the exhausted tobacco fields are known locally, are to be seen on many hillsides, either uncultivated or growing corn or other grain. Stock raising produces a large annual revenue, which could be considerably increased.

The mineral wealth of the county is known to be large, but it is mostly undeveloped. Magnetic iron ore, chromic iron ore, manganese, nickel in small quantities, corundum, serpentine, talc, and baryta are all found. Some corundum has been mined and shipped, much baryta has already been taken out and is still being mined by many individual miners. Recently a talc mine has been opened near Stackhouse, which is said to produce a very good quality of that mineral.

The timber found throughout Madison County is remarkably fine. Walnut trees 8 feet in diameter, poplars 10 feet in diameter, wild cherry, black birch, and buckeyes 3 or 4 feet in diameter are met with occasionally, while the common timber trees, such as oak, chestnut, and pine, are plentiful and of large size. Much timber has already been taken out and much is still being logged wherever the crude



FRENCH BROAD RIVER AT PAINT ROCK, N. C.

methods of lumbering prevalent can reach it. There are large mills at Stackhouse and at Putnam, and small portable mills are located wherever the timber can profitably be attacked, the lumber being wagoned to the railroad for shipment.

The geologic formations of the county are similar to those of Cocké County, Tenn. Close to the State line there is a belt of sandstone, which is succeeded by slates and schists. About a mile below Hot Springs the latter give place to limestone and dolomite, which above the springs are succeeded by sandstones, slates, and schists, and these in turn by the gneisses and granite which are the predominant rocks of the county.

The Hot Springs mentioned as being located in the limestone belt constitute one of the most interesting features of the region. They are 6 or 7 miles above the Tennessee line, directly on the banks of the river, some springs indeed bubbling up in the bed of the stream. As the name indicates, the water is warm, although of varying degrees of temperature, and possesses many valuable medicinal properties, said to be particularly efficacious in rheumatic cases. There is a large hotel at the springs, and many people come to take the hot baths, for which the waters are chiefly used.

Throughout its course in Madison County the river flows in a deep gorge which it has carved out in the gneisses and slates, now twining among the hills and now cutting through them, leaving at the latter places almost perpendicular walls of bare rock several hundred feet high or slopes of from 50 to 60 degrees covered with a sparse growth of gnarled and stunted trees clinging to the interstices of the rock.

Pl. XXXI is a view of the river at Paint Rock, near the North Carolina–Tennessee boundary, and shows both the forested slopes and the perpendicular rock walls in this portion of its course. As the river is ascended the sides of the gorge become gradually lower and less steep, and the country beyond the crests of the river bluffs loses somewhat its mountainous character, becoming instead a region made up of rounded hills and swells, with broader and more nearly level valleys between, a much larger proportion of the land being cleared, the cleared areas increasing from practically none on the extreme northern, western, and southwestern borders to probably 50 per cent of the area above the mouths of Walnut and Pawpaw creeks.

Throughout this area none of the closed basins which have been so notable a feature in some other areas were noted, but instead there seems to be a greater number of small stream channels, most of them carrying some water, which was not the case over a large part of the area drained by the South Fork of the Holston.

WATERSHED IN TENNESSEE.

The part of the drainage basin of the French Broad which is situated to the east of the town of Newport, Tenn., the western limit of the investigation, is comprised entirely within the limits of Cocke

County. The area immediately about Newport and for 5 or 6 miles to the east while hilly is not mountainous, and in many respects bears a close resemblance to the country seen along the South and Middle forks of Holston River, consisting, as it does, of rather low hills and broad ridges of gentle slopes largely cleared and grass covered. In parts of this area, particularly in the part seen from the road leading from Parrottsville to Newport, numerous small closed drainage basins or sinks were observed, many of them of large size and having pools of water in their bottoms. Occasionally, over an area of a square mile or more, these sinks occur in such numbers as to absorb the entire drainage, permitting, so far as could be observed, no water to find its way into the stream channels. This will tend to produce complications when the run-off from two similarly situated areas is compared if either area contains basins. None of the basins were noted above the North Carolina line. There are numerous springs of chalybeate and sulphur water in Cocke County, and large numbers of springs whose waters possess no medicinal properties.

It is along this part of the course of the stream that the far-famed scenery of the French Broad occurs, but with all its beauty the scenery barely equals that seen when the summit of the river bluffs has been reached, where vistas of mountain and meadow, woodland and stream are spread out before the eye, scenery of which the rugged beauty of that along the river has given no promise.

If the whole area of Cocke County be considered, about 40 per cent of the land is cleared and cultivated, according to the best information obtainable; but this includes a part of the vast Unaka mountain chain, with its outlying spurs and ridges, where the proportion of cleared land is exceedingly small, so that it is estimated that from 65 to 70 per cent of the area to the west of the mountains is cleared and under cultivation or in grass, which is one of the principal products.

The mountains rise very abruptly and steeply from the more level area, and the proportion of cultivable land on them is small, being confined to the stream valleys and to a few of the lower and gentler slopes. In some of the coves and gorges the soil is productive, but these areas are too small to be of value for grain growing. They are, however, adapted to the production of grass and fruit, although very little has been done in that direction. The principal valley is of course that of the main stream, which has an average width of about 1 mile and is exceedingly fertile, the soil, which is alluvial, being deep and producing, with good cultivation, from 50 to 100 bushels of corn to the acre, this being the principal crop. Oats thrive very well, wheat not so well. Of late years more of the land has been sown to grass, and the stock-raising industry now affords a considerable revenue to the people of the county. The price of land ranges from $1 and $2 to more than $50 an acre.

There is some very fine timber in Cocke County, mainly oaks of

various kinds, chestnut, maple, hickory, walnut, white and yellow pine, spruce, and other varieties. Formerly a great many shingles were made, mostly from white pine. A limited amount of lumber is sawed annually by the small country mills for local uses, and a much larger amount of timber is annually destroyed for the purpose of stripping tan bark or for railroad ties; but taken as a whole the timber industry is of little importance, and the same is true of manufactures in general. There is a small cotton mill at Newport, also one or two small sawmills and a flouring mill, and there are small sawmills and gristmills at various places in the county, but they are of little importance.

The mineral wealth in this section is very great, but so far as could be learned nothing has been done toward developing it. Iron is said to occur in paying quantity, also lead and baryta. Newport is just at the junction of the shales and the limestone, which there form a narrow valley, and for 5 or 6 miles up the river limestone and dolomite occur, the prevailing color being blue, though layers of gray rock are also found. The limestone and dolomite are succeeded by red shales, and these, for a fourth of a mile or more upstream, by white or grayish sandstones. Passing these sandstones, shales or slates are again met with, bands of conglomerate occurring at intervals, also a few layers of dolomite. The sandstone then makes its appearance again and continues several miles up the river, or to and beyond Paint Rock.

RAINFALL.

The total annual rainfall at Asheville is 42.6 inches, distributed as follows: Spring, 11.7 inches; summer, 13.8 inches; autumn, 7.7 inches; and winter, 9.4 inches. Asheville, however, is in a region of rather low precipitation compared with the rest of the mountain country, although the records of the station at Waynesville show that the annual precipitation between Asheville and Paint Rock is very near the amount stated. Records of stations above Asheville show that the annual rainfall increases very rapidly as the stream is ascended, and near the headwaters, but across the divide, are stations having a mean annual precipitation of between 72 and 73 inches, with an occasional record of more than 105 inches.

The distribution of the rainfall is favorable to a large annual run-off in the stream, since at the time when plant life and evaporation make the heaviest demands upon the precipitation the rainfall is greatest, and it is least in autumn and winter, when these demands are at a minimum. However, since the autumn precipitation is the least and plant life and evaporation are still rather active, the stream is then subject to periods of low flow, although the run-off per square mile is large when compared with streams draining areas out of the mountains, and remains so during even the periods of severe drought.

TRANSPORTATION.

Throughout the greater part of the basin of the French Broad the transportation facilities are poor, being mainly confined to the ordinary country roads, which as a rule are steep and rough, poorly graded and ill kept. The Knoxville branch of the Southern Railway follows the course of the stream very closely below Asheville, and the Spartanburg branch of the same system runs approximately parallel to it for a long distance in the upper part of its course, while the Murphy branch furnishes railroad facilities for the inhabitants of the valley of Hominy Creek. The Hendersonville and Brevard Railroad has recently been constructed from Hendersonville to Jeptha, in Transylvania County, furnishing an outlet for the products of the upper part of the basin. But owing to the character of the country the transportation facilities are less effective than they otherwise would be, and there seems no present prospect that the conditions will be bettered, though one or more additional lines of railroad have been projected to traverse the basin. On the whole, however, the transportation facilities of the area are better than those of any other section of western North Carolina, and in consequence it is better known to the outside world and is more prosperous than the areas to the northeast and the southwest.

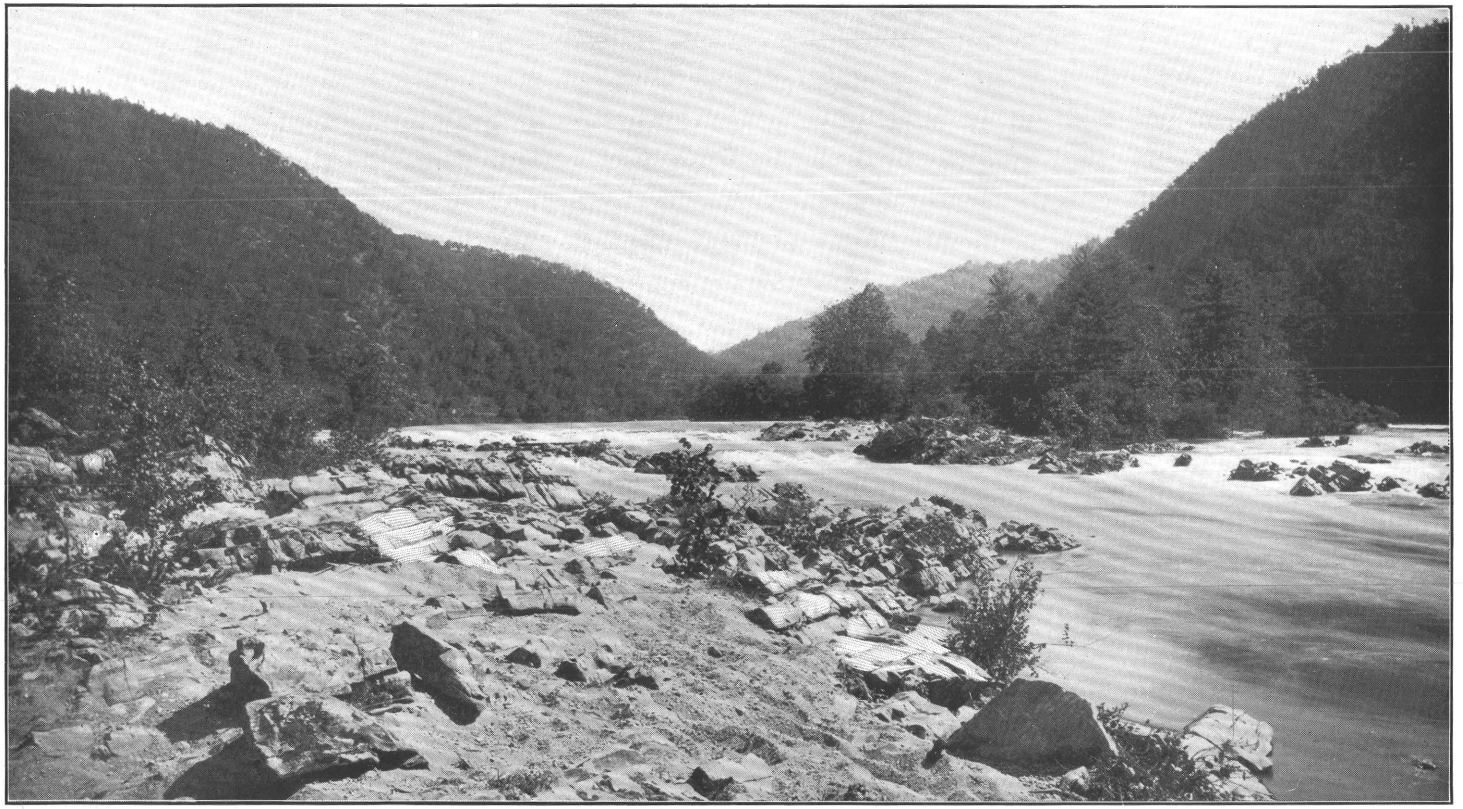
DISCHARGE MEASUREMENTS.

During the investigation a gaging station was established on the French Broad at Oldtown, Tenn., where measurements were made from time to time, also at other places along its course, as shown in the following table. The Survey has maintained a gaging station at Asheville since September, 1895, the results of which have been published in the annual reports.

Discharge measurements of French Broad River.

Date.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.			*Feet.*	*Sec.-feet.*
Sept. 4	Oldtown, Tenn	E. W. Myers and L. V. Branch.	1.00	867.0
Nov. 2	do	do	1.26	1,653.0
Dec. 15	do	do	1.30	1,976.0
Dec. 26	do	do		2,901.0
Sept. 7	One-half mile above Hot Springs, N. C.	L. V. Branch	19.35	938.0
Sept. 12	Alexander, N. C	E. W. Myers	17.15	840.0
Oct. 29	do	L. V. Branch	16.27	2,068.0
Sept. 18	Fanning Bridge, North Carolina	N. C. Curtis	16.22	1,161.0
Oct. 17	do	do	16.95	614.0
Sept. 17	Penrose, N. C	do	19.80	1,160.0
Sept. 13	Near Carson Creek, N. C	do	13.80	266.5
Oct. 15	do	do	13.90	206.5
Sept. 14	Eastatoe Bridge, North Carolina	do	12.40	113.0
Oct. 15	do	do	11.21	102.4

NOTE.—At regular stations of the Geological Survey gages are installed by which the rise of the river is measured, an increase in the gage height representing an increase in the discharge of the stream. This is true of the measurements in the above table at Oldtown. In making all of the other measurements, however, in each case a bench mark was established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. In these cases, therefore, an increase in the gage height means a lowering of the water surface and a corresponding decrease in the discharge of the stream.



MOUNTAIN ISLAND SHOAL, FRENCH BROAD RIVER, NORTH CAROLINA.

WATER POWERS.

In describing the fall and power of the French Broad we will start near Newport, Tenn., and follow upstream to its source. At the starting point, about 2 miles north of Newport, the river is a comparatively placid stream, flowing between willow-bordered banks and through broad and fertile grass-covered bottom lands, and this character is preserved for 5 or 6 miles, when there is an abrupt descent of about 4 feet over a rock ledge extending straight across the stream. Near these falls the bottom lands almost entirely disappear and the mountains begin to close in on the river, the hillside slopes, which are sparsely forested, varying from 30 to 50 degrees. Farther upstream an occasional broad bottom is to be seen, but the mountains continue to rise higher and higher as the stream is ascended, the river entering a gorge which reaches a very highly developed stage near Paint Rock. (See Pl. XXXI.) Throughout this distance, however, there is little concentration of fall in the stream, the fall averaging about 10 feet to the mile, following the course of the river, which is very tortuous in this section.

The stream preserves the same general character as far as Hot Springs, the average fall per mile between Paint Rock and Hot Springs being about the same as in the section between Paint Rock and Newport. Above Hot Springs, however, the character of the river changes abruptly, and from a smooth though rapid stream it becomes a tumultuous mountain torrent, dashing along among many huge bowlders and over the rock ledges which obstruct its course and project above the surface in jagged ridges, twining and curving around the hills between lofty and steep walls of rock, which are thinly clad with stunted trees. The river contains many islands and is in places very wide.

In the 7.7 miles between Hot Springs and the mouth of Brush Creek the total fall is 201 feet, giving an average fall of 26.1 feet per mile. There are several places in this distance where the fall is noticeably concentrated. The first of these is about one-fourth of a mile above Hot Springs and is known as the Mountain Island Shoal. At this shoal, shown in Pl. XXXII, a high and rocky island about 200 yards long divides the stream into two parts. The most noticeable concentration of fall is at the ends of the island, there being at the lower end an almost vertical plunge of between 4 and 5 feet, and at the upper end two plunges of about 3 feet each. There is also a fall of about 4 feet in the distance between these plunges, making a total fall of about 15 feet at this place. Below the island the river contracts suddenly to a width of about 100 feet and the water is very deep and sluggish. The railroad is on the north bank, crossing the stream a short distance below the island, and as the track is only a few feet above the level of high water, it offers an obstacle to the

development of the power. A development could be made, however, but at considerable expense, by constructing a wing dam from the upper end of the island diagonally toward the north bank, gradually decreasing the height of the dam upstream. This would throw as much of the water as might be desired to the south side of the island and away from the railroad, and then by building a dam across the south channel near the lower end of the island the flow of the stream could be controlled. Space for a power house on the island could be cleared by a small amount of blasting, and the power be transmitted to Hot Springs, where there is a large area of level land. This is by far the largest and most noticeable fall on the stream, and probably would afford a cheaper and easier development than any other.

As at this fall, so at all others between Paint Rock and Asheville, the proximity of the railroad to the stream renders it impossible to build high dams, though otherwise the conditions for easy and cheap construction are very favorable, for everywhere stone can be obtained in great quantities at comparatively small cost for blasting and transportation to the site of the work.

Although the average fall per mile in the stream channel between the head of the Mountain Island Shoal and the mouth of Brush Creek is very great, there are several places where it is still more concentrated, the first of these being just above the mouth of Laurel Creek, where the fall is estimated to be about 15 feet in a little more than one-fourth of a mile, and about 2 miles below Barnard Station, where there is another large fall within a short distance. Just below and a little above the mouth of Brush Creek there is still another large fall, the banks being very high, steep, and rocky, the stream comparatively narrow, and all of the conditions for the construction of a high dam very favorable, excepting the presence of the railroad. At almost any desired place within this distance—from the Mountain Island Shoal to Brush Creek—falls of from 15 to 20 feet can be obtained.

From the mouth of Brush Creek to Asheville, a distance of 29.3 miles, the stream is still very rapid, but the average fall per mile is much less than in the section just described, being about 15.4 feet, in general well distributed. Sites where falls of 10 feet or more can be obtained are numerous, though none of them were noted particularly.

The first power developed on this stream is at Marshall, Madison County, where, on the south bank of the river, the Marshall Milling Company has erected a flour mill with a capacity of 75 barrels per day, utilizing only a small part of the flow, which is turned aside by means of a wing dam about 200 yards long extending diagonally upstream about half the width of the river, from the upper end of which a very low dam has been built to the north bank of the stream, both dams being made of logs and giving a fall of 13 feet at the wheel.

Discharge measurements of tributaries of French Broad River in North Carolina— Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
Sept. 14	West Fork of French Broad River.	Near mouth	N. C. Curtis	2.20	149.0
Oct. 15	do	do	do		62.0
Sept. 14	Middle Fork of French Broad River.	Bridge 20 yards above ford	do	5.35	77.0
Do	South Fork of French Broad River.	Footbridge at ford of main road.	do	10.3	71.0
Oct. 15	East Fork of French Broad River.	Near mouth	do	10.2	46.0
Sept. 16	Tucker Creek	Two hundred yards above mouth.	do	4.61	28.0
Sept. 13	Cathey Creek	Ford of Brevard-Jeptha road	do	6.7	30.2
Sept. 17	King Creek	Brevard road	do	4.71	15.46
Do	Davidson River	Near mouth	do	16.45	151.77
Oct. 16	do	do	do	16.75	70.20
Sept. 17	Little River	Three-fourths mile above mouth.	do	13.66	182.8
Oct. 16	do	do	do	14.35	69.2
Sept. 17	Boylston Creek	Near mouth	do	5.35	28.65
Do	Mills River	Bridge on Old Haywood road	do	13.11	211.64
Oct. 17	do	do	do	13.4	94.0
Sept. 18	Mud Creek	Near mouth	do	5.11	108.0
Do	Caney Creek	Bridge on Westfall's place	do	10.1	60.0
Do	Avery Creek	Bridge on road from Mills River to Asheville.	do	6.56	11.31
Sept. 19	Hominy Creek	Asheville	do	15.1	80.0
Oct 17	do	do	do	15.4	24.0
Sept. 19	Swannanoa River	Biltmore	do	2.91	76.33
Sept. 20	North Fork of Swannanoa River.	Three miles above Swannanoa.	do	16.07	21.45
Do	Flat Creek	Two miles below Black Mountain Station.	do	4.05	22.83
Sept. 12	Beaverdam Creek	Fifty yards above mouth	E. W. Myers	5.09	1.46
Oct. 30	do	do	L. V. Branch	5.08	4.10
Sept. 16	Lees Creek	Olivette	E. W. Myers	11.15	3.95
Oct. 30	do	do	L. V. Branch	10.95	2.29
Sept. 12	Newfound Creek	At mouth	E. W. Myers	17.75	9.41
Sept. 16	do	Three-fourths mile above mouth.	do	10.19	34.16
Oct. 30	do	do	L. V. Branch	10.44	20.23
Sept. 12	Reems Creek	At mouth	E. W. Myers	12.1	4.89
Oct. 30	do	do	L. V. Branch		9.0
Sept. 11	Flat Creek	do	E. W. Myers	18.05	5.33
Oct. 29	do	do	L. V. Branch	17.43	5.0
Sept. 12	Sandymush Creek	Bailey	E. W. Myers	9.73	21.72
Sept. 17	do	do	do	9.43	55.23
Oct. 30	do	do	L. V. Branch	9.53	45.0
Sept. 16	Turkey Creek	Blackwell Springs	E. W. Myers	7.97	35.24
Oct. 30	do	do	L. V. Branch	8.32	16.24
Sept. 17	Big Ivy River	One-eighth mile below mouth of Bull Creek.	E. W. Myers	2.55	47.59
Oct. 29	do	do	L. V. Branch	2.72	41.72
Sept. 8	Little Pine Creek	One hundred yards above mouth.	do	5.84	3.33
Oct. 31	do	do	do	5.76	6.0
Sept. 8	Pawpaw Creek	One mile above mouth	do	4.6	0.35
Sept. 10	Walnut Creek	At mouth	do	23.24	1.36
Oct. 31	do	do	do	2.35	2.24
Sept. 8	Big Pine Creek	One hundred yards above mouth.	do	6.07	4.85
Oct. 31	do	do	do	6.01	4.45
Sept. 8	Big Laurel Creek	Two hundred yards above mouth.	do	16.13	49.0
Sept. 18	do	do	E. W. Myers	15.77	55.0
Sept. 7	Spring Creek	Near Hot Springs	L. V. Branch	2.00	15.0
Nov. 1	do	do	do	2.07	16.0
Sept. 7	Shutin Creek	do	do	2.61	0.45

NOTE.—In making the measurements recorded in the above table bench marks were established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. An increase in the gage height, therefore, means a lowering of the water surface and a corresponding decrease in the discharge of the stream, the reverse of the results at the regular stations of the Survey, where gages are installed and where an increase in the gage height represents an increase in the discharge of the stream.

There are several other localities between Marshall and Asheville where small powers could be developed in the same way, but no attempts have been made to do this. There is a project to develop a small fall in the stream just below Asheville, to obtain power to operate street cars and electric lights, and a low dam has been built, but no other work has been done.

Above Asheville the character of the stream again changes and it becomes a placid river with a current which though rapid when compared with the streams of the Coastal Plain is very sluggish when compared with its mountain neighbors or with its own current a few miles below. The bed of the stream is overlain with a stratum of coarse sand and gravel, and in general is rather smooth, though the current is interrupted at intervals by ledges and bowlders, and the fall is very much more gradual and evenly distributed than is usual with mountain streams. The distance from Asheville to Brevard, by river, is 48.35 miles, and the total fall is 130.9 feet, making the average fall per mile only 2.7 feet. Indeed, so small is the fall that at one time the United States engineers did a great deal of work on this portion of the stream to render it navigable. Formerly a small steamboat plied the river, but it did not pay expenses, and of late no attempt has been made to navigate the stream.

There are two principal obstructions to navigation, the first of these 8½ miles above Asheville, and known as the Sandy Bottom Shoal. This is the largest shoal on this part of the river, the total fall being 22.6 feet in a distance of 18,000 feet. Three and one-half miles above this is the Long Shoal, where the fall is 18.3 feet in 12,920 feet. Above this and as far as Eastatoe Ford, about 1 mile above Jeptha, the stream flows placidly along through a broad and level valley and offers no possibility of power development. Above the ford, however, the fall rapidly increases, but the stream divides into the North and West forks, both of which are too small for consideration as power streams.

TRIBUTARIES OF FRENCH BROAD RIVER.

DISCHARGE MEASUREMENTS.

During the investigation the drainage basins of the important tributaries in North Carolina were visited and the following measurements made:

Discharge measurements of tributaries of French Broad River in North Carolina.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
Sept. 14	North Fork of French Broad River.	Two hundred yards above mouth of West Fork.	N. C. Curtis		100.6
Oct. 15	do	do	do	13.2	51.8
Sept. 16	do	Bridge on Brevard-Webster road.	do	14.98	107.48
Do	do	Ford on road between Tucker and Shoal creeks.	do	7.3	75.0

the mountain slopes over the basin, and much of the available timber has been cut, but the ground is densely shaded by the undergrowth and the nontimber trees.

This stream was not gaged, the quantity of water which was flowing, estimated to be about 0.5 second-foot, being too small to admit of measurement. It was stated by residents that the stream was then at its lowest stage. The maximum flood rise is between 4 and 5 feet.

SHUTIN CREEK.

The basin of this stream is similar to that of Wolf Creek, except that very little timber has been cut.

SPRING CREEK.

Spring Creek, entering the river from the south, at Hot Springs, is the largest tributary yet described. It rises in the extreme southern corner of Madison County, near Sandymush Bald, on the northeastern slope of the Newfound Mountains, and flows in a general northerly direction for a distance of about 20 miles, draining an area of 66 square miles. Its basin is in the midst of the high mountains, is steep, rough, and rugged, and is almost entirely forest covered, the cleared land being confined to the narrow stream valleys which constitute a very small proportion of the whole area, probably less than 10 per cent. The stream attained its minimum stage during the autumn of 1900, when it was measured and found to be carrying 0.45 second-foot. It has a maximum rise of about 6 feet during floods, which are said to be violent, but of short duration.

BIG LAUREL CREEK.

This stream, the next tributary of the French Broad, rises in two forks, one in the Bald Mountains, in the extreme northeastern part of Madison County, and the other in the Unaka Mountains, in the extreme northern part of the county. It drains an area of 141 square miles. Its basin is very rough and rugged, with a large proportion of steep, forested slopes, ranging from 15 to 50 degrees and showing a great deal of exposed rock, which is of a slaty character. For a considerable distance above its mouth the stream is in a deep gorge and could not be followed, but it was ascertained that the country was extremely rugged and contained no cleared land. The hills there lack the symmetry of those seen farther upstream, having steeper slopes and being broken into irregular shapes by the small valleys and gullies which extend up their sides.

The proportion of cleared land in the basin is small, not more than 25 per cent of the area being under cultivation. The cultivated areas are for the most part confined to the stream valleys and the lower uplands. Within the last ten years much land has been partially

The principal drainage basins are briefly described on the following pages, in order upstream.

LONG CREEK.

The first tributary of any size entering the French Broad above Newport, Tenn., is Long Creek, which flows in from the north, draining a small area. At the mouth the valley of the stream is very narrow, the mountains rising high and steep on either side, in walls of almost bare rock; but farther up the valley widens greatly, and it is estimated that above the forks about half of the basin is cleared land, being made up for the most part of rather low hills, with gentle side slopes timbered in pine and oak. Corn and wheat are the principal crops; about one-third of the cleared land is in grass.

At the time the stream was visited it was extremely low, its flow being too small to gage, but it was carrying a quantity of water estimated to be between one-fourth and one-third of a second-foot. The stream is said to rise very rapidly after rains, reaching an extreme height of about 4 feet above low water. The floods are of short duration.

BIG CREEK.

Big Creek, the next tributary, enters the river from the south, near Del Rio, draining an extensive area in the high and rugged Stone and Smoky mountains, almost the entire basin being forest covered and very steep and rough, with a great deal of rock exposed on the hillsides. The cleared land is confined entirely to the narrow strips bordering the stream, but it is small in amount, being probably less than 5 per cent of the area of the basin, which may thus be considered entirely forested.

When this stream was visited it was very low, carrying an estimated discharge of possibly 2 second-feet. It rises rapidly after rains, in consequence of the great steepness of the hillside slopes over its basin, and attains a maximum height of from 5 to 6 feet above low water.

LAUREL BRANCH, MOONEYHAM BRANCH, AND ROCK CREEK.

These are very small streams which are practically dry during severe droughts.

WOLF CREEK.

Wolf Creek is the next tributary. It is a small stream entering from the south, draining a long and narrow area which with the exception of one or two small patches of an acre or two near its mouth may be considered entirely wooded. The basin is rough and mountainous, with very steep slopes. The forest growth consists for the most part of pine, with a dense undergrowth and with some oak and chestnut. Extensive lumbering operations have been carried on on

cleared by cutting away the undergrowth and deadening the larger trees, the deadened areas being largely cultivated in tobacco or corn. The soil is in part red, clayey, and very impervious to water, and in part loamy, and is not very fertile.

Extensive lumbering operations are now in progress over the basin, many small portable mills being located in close proximity to the timber, the lumber being hauled to the railroad at either Putnam or Stackhouse. Poplar seems to be the timber most sought, though oak and pine are also cut. Much chestnut remains, and trees of many other varieties are found.

At its mouth the flood rise of the creek is from 7 to 8 feet. It never falls very low, the lowest stage known having been reached in the autumn of 1900, when the discharge was about 49 second-feet. While the stream is capable of furnishing power in large amounts, it is utilized by only two or three small gristmills, grinding grain for local uses.

Some baryta has been found in the basin, but so far as could be learned the principal deposits of this mineral are along the main river, on the hills between Stackhouse and Marshall. Talc is also found in this region, and some has been recently taken out which is said to be of excellent quality.

Shelton Laurel Creek.—This stream is the principal tributary of Big Laurel Creek. Its drainage basin is very similar to that of the main stream, although as the creek is ascended the topography flattens out to some extent. The stretch of the river between White Rock and Alleghany is much more level and more extensively cultivated than any seen lower down the stream. The only extensive lumbering operations carried on in the basin are in this locality, being mainly directed against the timber which can be reached from the small tributary streams, although the operations are more or less general.

The soil seems similar to that along Big Laurel Creek, but it contains a very large proportion of rock fragments ranging in size from a pea to several inches in diameter, and more quartz is seen, forming now an important part of the country rock.

The slope of the channels of this creek and its branches is very great, the storm waters reaching the streams almost immediately, the main creek rising very rapidly and falling as quickly.

BIG PINE CREEK.

The next tributary gaged was Big Pine Creek, which enters the French Broad from the south, opposite Barnard, draining a considerable area which is largely forest covered, the cleared and cultivated land being confined for the most part to the stream valley and the lower hills. The hillside slopes over the basin are almost uniformly steep and rocky, and the greater part of the area is mountainous.

WALNUT, LITTLE PINE, AND HAYES CREEKS.

Walnut Creek, entering from the north, about 3 miles above Barnard, is a stream of about the same size and general character as Big Pine Creek, except that the proportion of cleared and cultivated land in its drainage basin is considerably greater, the valley of the stream being wider and the slopes less steep and rugged, the topography consisting for the most part of rather low and rounded hills, largely grass covered, although the upper part of the basin is steep and mountainous. The cleared land amounts to probably one-third of the whole area, possibly more. The stream reached a very low stage in the autumn of 1900, lower than ever before known, it is stated. The discharge measured on September 10 was 1.36 second-feet. The maximum rise in flood is about 4 feet.

Little Pine Creek and Hayes Run are entirely similar streams, though much smaller.

IVY RIVER.

Ivy River, the next tributary, enters the French Broad from the east, and is the principal tributary in North Carolina. It rises on the western slopes of the Great Craggy Mountains, near Yeates Knob, the headwaters being at an elevation of about 5,000 feet, and flows in a general westerly direction, joining the French Broad about $2\frac{1}{2}$ miles above Marshall, draining an area of 176 square miles.

For about 3 miles above its mouth the valley of the river is very narrow and the banks of the stream are steep, showing much exposed rock, but they are forested with a growth of considerable density. Above this 3-mile stretch, although the gorge formation still persists for a considerable distance, the hills do not rise to so great heights, and the country beyond the summit of the bluffs is composed of a succession of hills and ridges of moderate height, very sharp topped, and inclosing narrow V-shaped valleys, the hillside slopes ranging from 10 to 30 degrees. A large part of the area—perhaps 75 per cent—is cleared. It is probable that nearly 50 per cent of the whole area drained by Ivy River is either under cultivation or is grass. Throughout this part of its course, or to beyond Grantville, the stream channel is very tortuous.

As the stream is ascended the topography becomes less strongly marked and the country better fitted for agriculture and stock raising, until a short distance below Barnardsville the mountains begin again to encroach on the river and the cultivated lands are confined to the immediate valley of the stream. There is considerable timber yet standing in the high mountains about the headwaters, much of it being inaccessible.

Corundum has been found near Democrat, nickel stainings have been observed in the rocks at many localities, and a vein of serpentine of good quality crosses part of the basin.

The stream has a large fall throughout its length, the average fall per mile between its mouth and Barnardsville, at the junction of the forks, being about 43 feet. It could be made to furnish power in large amounts, but as yet very little has been done in that direction. About 1 mile above its mouth there is a fall of 6 feet in 200 feet, over ledges of solid rock, the width of the stream being between 60 and 70 feet.

The most important power site on the stream is about 2 miles above its mouth. Here Mr. W. B. Ellis, of Asheville, and others, have planned a large power development, which is about half completed. The plans include an arched masonry dam 95 feet in height, 360 feet long on top, 60 feet wide at base, and 12 feet thick to the 83-foot level. The race is to be 860 feet long from the dam to the power house, built partly in embankment and partly in open rock cut, with 100 feet of tunnel and 250 feet of steel flume, which will carry the water to a pair of 22-inch turbines. It is stated that the flow of the stream will be sufficient, with proper storage, to develop 2,000 horsepower under a working head of 110 feet, the natural flow of the stream yielding 1,000 horsepower under that head. The power is to be transmitted electrically to Asheville, Marshall, and other places at a potential of 10,000 or 11,000 volts. During the autumn of 1900, when the plant was last visited, all work had been suspended, due largely, it was rumored, to lack of water.

On the basis of 1,000 horsepower developed continuously, the flow of the stream at this place is calculated as follows: It is safe to assume that the losses of energy in the wheels, dynamos, and in transmission will amount to at least 20 per cent of the total energy due to the water, and as it is the intention to deliver 1,000 horsepower at the end of the transmission line, this will require of the stream a flow capable of developing 1,250 gross horsepower with a head of 110 feet, or 11.36 gross horsepower per foot of fall. One second-foot of water falling 1 foot will yield 0.1135 gross horsepower, so that in order to produce 11.36 gross horsepower per foot fall a flow of practically 100 cubic feet per second will be necessary, and during times of drought the stream does not carry that amount of water. When these notes were made, in October, 1899, although the discharge could not be gaged, it was estimated to be not much more than 50 second-feet. When the locality was visited in the fall of 1900, at a time when the stream was said to be very low, the discharge was gaged a short distance above the head of the backwater from the dam and a flow of 41.72 second-feet was found.

Just above the mouth of Little Ivy River there is a gristmill with an 8-foot dam, giving a fall of 10 feet, and at Democrat there is a similar mill.

SANDYMUSH CREEK.

The next tributary is Sandymush Creek, which joins the French Broad about 4 miles above the mouth of Ivy River. This creek rises on the northern slopes of the Newfound Mountains, in a number of small creeks which have a general northerly or northeasterly course. Including Turkey Creek, which joins it near its mouth, it has a drainage area of 86 square miles. Near its mouth and for a considerable distance upstream the creek lies in a deep and narrow gorge, but farther up the valley widens very much and the topography becomes less strongly marked over a large part of the area. The high hills which inclose the valley are rough and steep, most of them ranging from 15 to 30 degrees, but many of them being much steeper. The proportion of cleared land is smaller than in the basin of Turkey Creek, being less than half of the whole area. Above the junction of Little Sandymush Creek the area is entirely mountainous and forested, with the exception of small, narrow areas immediately along the stream. Pine trees seem more numerous than heretofore noted, the character of the hard-wood growth remaining the same, also the agricultural products. The soil is a fertile loam, the country rock a much laminated and contorted gneiss.

The stream is said to have reached its minimum stage of flow during the fall of 1900 (see measurements in table on page 128). During floods it is subject to violent rises of from 6 to 7 feet.

Turkey Creek.—The valley of this tributary of Sandymush Creek is very different in character from that of the main stream. In proportion to its size its valley is broader than that of any stream yet described. The proportion of cleared land seems to be about 75 per cent over the lower part of the basin, and is probably 66 per cent of the whole area. The topography is a succession of hills and ridges divided by broad valleys, and the hillside slopes are comparatively gentle. The soil is deep and fertile. The country rock seems without exception a gneiss. At the time the stream was visited all of the land except that in corn was covered with grass, and this is true of all this section of country during the fall and summer months. A large part of the area is planted in wheat, and when that is harvested grass quickly covers the land, remaining until seeding time comes again.

The creek falls very low at times, reaching, it is said, its lowest stage in the fall of 1900, and though subject to floods of 6½ to 7 feet, these are rare and generally of short duration.

FLAT CREEK.

The next tributary is Flat Creek, which enters the French Broad from the east, about 1 mile below Alexander. It is a small stream rising on the western slope of the Flat Creek Mountains and draining

a broad and flat valley of considerable extent. The topography is in broad and low flattened hills and ridges, the hillside slopes being very gentle. Seemingly about two-thirds of the area is cleared land, about one-half of it in grass and the other half chiefly in wheat, corn, and tobacco. The soil appears deep and fertile. No exposed rocks were seen, though the basin is underlain by gneiss or granite. The stream is subject to periods of very low flow, and during floods it rises from 5 to 6 feet at the mouth.

REEMS, NEWFOUND, AND BEAVERDAM CREEKS.

Reems Creek, the next tributary, enters the river from the east a short distance above Alexander, and seems in every respect similar to Flat Creek, just described. It was gaged at its mouth, with the results given in the table on page 128. The maximum flood rise is from 5 to 6 feet.

Newfound Creek, entering the French Broad from the southwest, rises close to the headwaters of Turkey Creek, near Turkey Creek Pinnacle, and in soil, topography, and general characteristics is a stream similar to Turkey Creek.

Beaverdam Creek, entering the French Broad from the east a short distance below Owenby, drains a long, narrow, and rather flat valley containing a large proportion of cleared land, but it is a small and unimportant stream.

SALUDA RIVER.

About 10 miles above Greenville, S. C., Saluda River is formed by the confluence of the North Saluda and the Middle Saluda. The South Saluda, a stream nearly or quite as large as the two other streams combined, enters the Middle Saluda a few miles above the junction of the latter stream with the North Saluda. The watershed of these three branches is defined by the North Carolina–South Carolina boundary line, extending from the Greenville-Pickens county line in South Carolina to the western slope of Rocky Spur, 5 miles southeast of Saluda, N. C., the total length being about 36 miles and the drainage area estimated at about 380 square miles. The watershed includes the southern slopes of the Saluda Mountains and a portion of the Blue Ridge. Below the junction of the three forks the main stream flows in a general southeasterly direction through the State of South Carolina, joining Broad River near Columbia, to form the Congaree.

The steep slopes at the headwaters of the river are densely forested, but the valleys of even the smaller tributary streams have been cleared. Oak and hemlock predominate, but pine and other timber are frequently intermingled. The trees are not in good condition, however, owing to frequent scars from fire and other destructive

agencies. The soil is largely composed of material derived from the decomposition of granite and gneiss. In many parts of the basin it has a thick layer of humus and is very fertile; in other parts, however, a clay is formed which is impervious to water and not well suited to agriculture. The soil in the former places will not withstand the action of flowing water, and where the forests have been cut considerable washing of the top soil can be observed. In the lower part of the drainage basin the soil is sandy and is largely devoted to agriculture, the chief crops being cotton, sugar cane, and sweet potatoes.

The Saluda is largely outside of the mountain region, its headwaters only being on the slopes of the Blue Ridge. For this reason it is perhaps not of as great importance in the investigation of the proposed Southern Appalachian Park as the streams which rise and flow for many miles through the mountains. The preservation of the forests, however, is of the greatest importance, owing to the nonresistant character of the soil and the danger of heavy wash and floods.

NORTH SALUDA RIVER.

This stream rises on the western slope of Rocky Spur and Hogback Mountain, at an elevation of 2,600 feet. It is 25 miles long and flows in a general southwesterly direction, joining the Middle Saluda about 3 miles below the confluence of that stream with the South Saluda. The elevation at the junction is about 980 feet. The average fall per mile is therefore about 65 feet. Most of this fall, however, is on the upper portion of the stream, the average fall per mile for a distance of 20 miles above the mouth of the North Saluda being only about 25 feet.

Around the headwaters of the stream about 15 per cent of the watershed has been cleared. The western sides of Rocky Spur, Hogback Mountain, and Glassy Mountain and the eastern slopes of the Saluda Mountains have been very little cleared, while the southern slopes of the latter mountains are especially well wooded. No lumbering is being done in this section, and the land cleared for farming purposes is proportionately small. As a natural consequence of its forested basin the waters of the stream are never very muddy, although they are said to contain more sediment than either the Middle Saluda or the South Saluda.

After leaving the mountains the flood plain of the river broadens, and the wide, flat bottoms are given up largely to agriculture, the chief crop being corn, although considerable cotton is raised. Discharge measurements were taken on the North Saluda 2 miles below Humphries's store, at Lima, and at Marietta, with the results given in the table on page 138. The river has an average annual fluctuation of 10 feet.

Fall Creek, a small tributary flowing into the North Saluda about midway between Humphries's store and Lima, has a fall of about 120 feet to the mile and a mean discharge of 6 or 8 second-feet.

MIDDLE SALUDA RIVER.

The Middle Saluda rises in Jones Gap, in the Blue Ridge, on the North Carolina–South Carolina boundary line, at an elevation of 3,000 feet. Its total length is about 20 miles; the elevation at its mouth 990 feet. It has an average fall of 100 feet to the mile, but, as in the case of the North Saluda, the fall is much greater in its upper portion than in its lower course, the average fall for 10 miles above its mouth being only 11.6 feet per mile.

The drainage conditions affecting the flow of the stream are similar to those of the North Saluda. Its flood plain is quite broad below Riverview and is under cultivation. The soil in the river bottoms is rich and loamy and black in color, while the hills are covered with a deep, rather rich, light-red soil. A large amount of cotton is raised around Marietta, and below that place cotton constitutes the chief crop.

The water power is better than that of the North Saluda. The Cleveland mill, on Mill Creek, a tributary from the east, is a small sawmill and gristmill having a working head of about 12 feet. Below it shoals are quite frequent on the main stream. Opposite Marietta there is a shoal a half mile long, called Long Shoal. The fall is possibly 10 feet in 200 feet. Two miles below the Long Shoal there is a sawmill and gristmill having a dam about 6 feet high and a working head of 12 or 15 feet. The average annual fluctuation of the Middle Saluda is 9 feet.

SOUTH SALUDA RIVER.

This branch has a total length of 30 miles. It rises just behind Pinnacle Mountain, at an elevation of 2,700 feet. The difference in elevation between its head and mouth is 1,720 feet, the average fall per mile 57 feet. It has one large tributary, viz, Oolenoy (sometimes called Illinois) Creek, a stream about 10 miles long, with an average fall of 30 feet to the mile below Sunnydale. It has wide and fertile bottom lands, planted chiefly in corn. The upper watersheds of both South Saluda River and Oolenoy Creek have been practically untouched by the woodman's ax.

The only fall observed on the South Saluda was 8 miles west of the Cleveland mill, just below the bend in the stream. The fall there is 30 feet in 100 feet, but the building space is rather cramped. The flood plain of the river varies in width from 50 to 200 yards, and the soil is deep and rich.

The scenic features of the region surrounding the headwaters of the South Saluda and the Middle Saluda are remarkably striking.

The southern slopes of the Blue Ridge are very steep. Table Rock, a mountain with an elevation of 3,157 feet, is surrounded by an escarpment of bare rock on all sides except one, and presents a very forbidding appearance. There is a popular summer resort, owned by Furman University, on Cæsars Head Mountain.

DISCHARGE MEASUREMENTS.

During the investigation measurements were made of the North Saluda, the South Saluda, the Middle Saluda, and Fall Creek, as shown in the following table. A gaging station has been maintained on the main river at Waterloo, S. C., since August 30, 1896, the results obtained being published in the subsequent annual reports of the Survey.

Discharge measurements of Saluda River and tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
1901. May 24	Saluda River	Greenville, S. C	N. C. Curtis	34.5	1,594.0
1900. Sept. 7	South Saluda River.	Freeman Bridge, below mouth of Middle Saluda River.	do	14.1	223.0
Oct. 14	do	do	do	14.1	171.0
1901. May 3	do	do	E. W. Myers	12.4	469.0
1900. Sept. 7	do	2 miles above mouth of Middle Saluda River.	N. C. Curtis	6.0	188.0
Oct. 14	do	do	do	6.0	134.0
1901. May 3	do	do	E. W. Myers		290.0
1900. Sept. 7	Middle Saluda River.	1 mile above mouth	N. C. Curtis	11.75	68.0
Oct. 13	do	do	do		55.0
1901. May 2	do	do	E. W. Myers	10.3	181.0
1900. Sept. 7	North Saluda River.	Iron bridge at Marietta	N. C. Curtis	14.7	58.2
Oct. 13	do	do	do	14.17	80.0
1901. May 3	do	do	E. W. Myers	13.5	163.0
1900. Sept. 6	do	Bridge on Lima-Cleveland Mill road.	N. C. Curtis	12.9	56.1
Do	do	2 miles below Humphries's store.	do	14.2	26.1
Do	Fall Creek	Bridge on road to Lima	do		[a]15.0

[a] Estimated.

NOTE.—In making the measurements recorded in the above table bench marks were established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. An increase in the gage height, therefore, means a lowering of the water surface and a corresponding decrease in the discharge of the stream, the reverse of the results at the regular stations of the Survey, where gages are installed and where an increase in the gage height represents an increase in the discharge of the stream.

BROAD RIVER.

PHYSICAL FEATURES.

Broad River rises on the eastern slope of the Blue Ridge, in McDowell County, N. C., between the Swannanoa and the Edmondson mountains. It flows in a southwesterly direction through Hickory Nut Gap (see Pl. XXXIII), until it is joined by Green River, when it bends to the east and maintains that course for about 20 miles. After it is joined by the First Broad it turns abruptly to the south and crosses the North Carolina boundary line near Shelby. The river and its tributaries were examined as far down as Dellinger, S. C., about 1 mile from the State boundary line. Its drainage area in North Carolina includes portions of Henderson, Polk, Rutherford, McDowell, and Cleveland counties, and aggregates 1,400 square miles. Its total drainage area is 4,950 square miles.

Three important branch streams contribute their waters to those of Broad River, two entering from the north, called First Broad and Second Broad, and the other entering from the west and known as Green River. These streams drain an area of the Blue Ridge and adjacent ridges extending to the State boundary line in Henderson County to and including the south side of the South Mountains in Rutherford and Cleveland counties. Pool Creek, a small branch from the south, discharging 6 or 8 cubic feet per second, is interesting on account of the pools which have been formed through the action of the water. There are three of these pools, each resembling a huge auger hole 6 feet in diameter. No definite information was obtainable as to their depths. Buffalo Creek, a small stream rising on the east side of the Bald Mountains and entering Broad River from the north, has a wide flood plain near its mouth and an average rise of 6 feet. Just above Ayr it is said to have a fall of 30 feet. This stream was not visited.

After leaving Batcave, where it is joined by Hickory Nut Creek (a typical headwater tributary shown in Pl. XXXIV), Broad River flows for 6 miles through a gorge which is justly famous for the grandeur of its scenery and the number of interesting natural curiosities. The mountains rise abruptly on either side to a height of 200 feet above the stream bed, and for about three-fourths of the way up are clothed with a thick forest growth. The upper side of each slope is guarded by an escarpment of granite absolutely bare of all verdure. This wall of rock varies in height from 200 to 1,000 feet. On the northeast corner of Sugarloaf Mountain and overlooking the gorge is a perpendicular mass of rock called Chimney Rock, which is detached from the face of the mountain and stands a massive silhouette against the sky. Its greatest height is 213 feet, its diameter at the summit 60

feet. The top of the rock is reached by a wooden stairway. A half mile directly west of Chimney Rock are the falls of Fall Creek, which are said to have a sheer drop of several hundred feet, but the quantity of water is insufficient for water power. On the left bank of the river is a mountain known as Old Rumbling Bald.

The region possesses a great variety of scenic and agricultural features. The soil is generally loose and porous. The headwaters of Broad and Green rivers rise among the high peaks of the Blue Ridge, and after winding their way through gaps and gorges finally emerge and flow through a region of low, rolling hills. There is very little bottom land along any of the larger tributaries. The only extensive stretches observed were along the lower portions of Whiteoak Creek and Cove Creek. The entire region is very healthy. The country east of the Blue Ridge, including the watershed and the drainage basin of Broad and Green rivers, is fair for farming purposes, though the soil is not especially rich. The chief crops in this section appear to be corn and wheat.

RAINFALL.

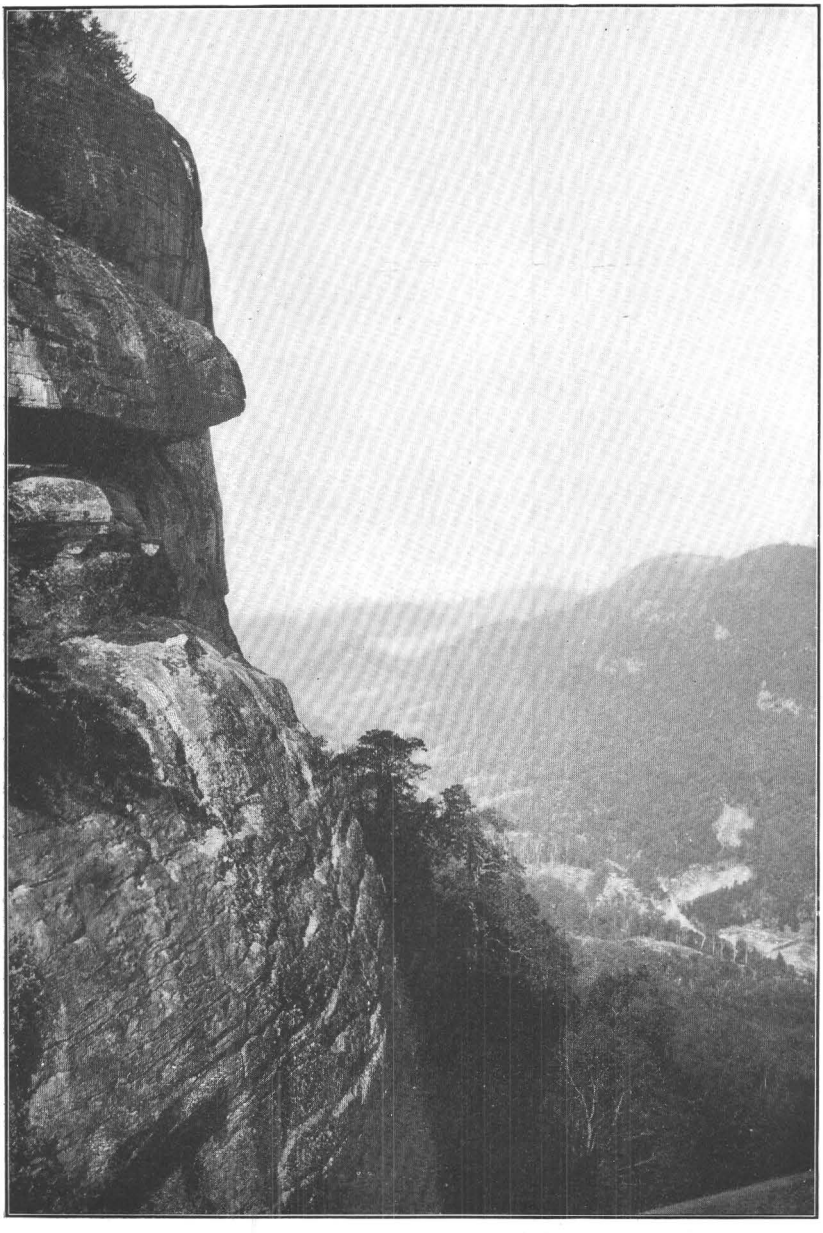
The rainfall in the basin of Broad River is approximately 51 inches, distributed throughout the year as follows: Spring, 13 inches; summer, 13 inches; autumn, 10 inches; and winter, 15 inches. The rainfall in the region above the headwaters is, however, probably much greater than this. The bed of the stream is of rock, clay, sand, or gravel, but in many places the banks are low and the bottoms are overflowed during freshets.

FORESTS.

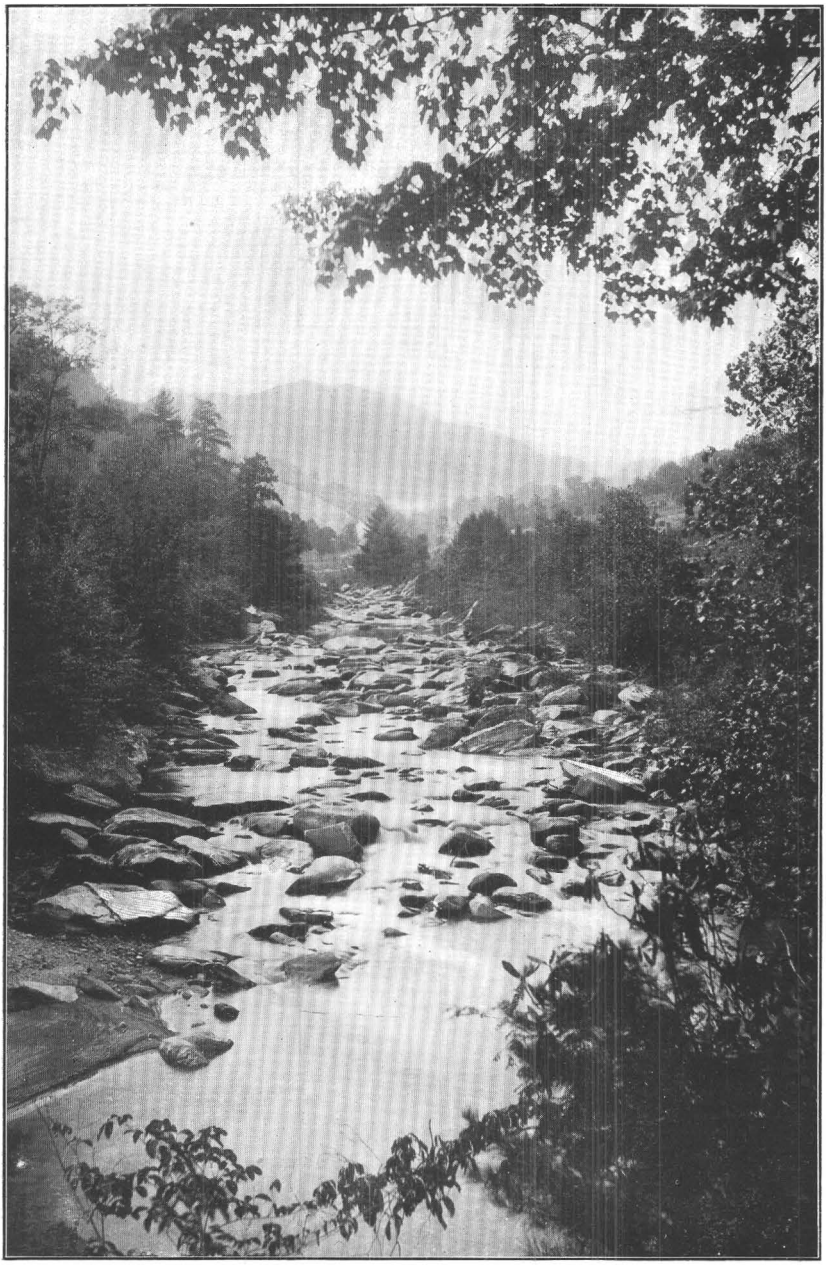
The timbered areas are comparatively small. Very little clearing has been done around the headwaters of either Broad River or Green River. The drainage basins of the Broad proper, the First Broad, and the Second Broad contain little valuable timber. For 2 miles above Batcave the land has been considerably cleared for farming, corn being the chief crop. The upper watershed of Reedy Patch Creek has been entirely cleared, and extensive clearing has been done around the heads of Cove, Maple, and Mountain creeks.

MINERALS.

The mineral wealth of the Broad River region is considerable. Deposits of gold are found about the headwaters of the First Broad, the Second Broad, and Silver and Muddy creeks, and these have been worked in a crude way since 1830. Several mines are also being worked on the flanks of the South Mountains, the ore being a



HICKORY NUT GAP FROM CHIMNEY ROCK, NORTH CAROLINA.



HICKORY NUT CREEK, NORTH CAROLINA.

very good grade of sulphuret. Here the famous Bechtler dollar was formerly coined. Monazite is extensively mined and shipped to the North and to foreign countries. Copper, corundum, and tin are among the minerals obtained.

DISCHARGE MEASUREMENTS.

During the investigation two gaging stations were established on Broad River, one at Dellinger, S. C., and the other near Alston, S. C., and measurements were made at these stations and at other places on the main river, as shown in the following table. Measurements of the tributary streams are given in the table on page 143.

Discharge measurements of Broad River.

Date.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.			*Feet.*	*Sec.-ft.*
Feb. 26	Near Alston, S. C.	E. W. Myers	5.40	8,913.0
Apr. 18	do	do	6.28	
Apr. 20	do	do	13.60	44,456.0
May 22	do	do	3.40	4,406.0
July 5	do	do	4.25	5,962.0
Aug. 17	do	do	2.80	2,840.0
1901.				
May 7	Near Blacksburg, S. C.	do	2.50	2,418.0
1900.				
Aug. 30	At Dellinger, S. C.	do	0.80	1,430.0
Aug. 28	Ford 1 mile above mouth of Second Broad River, North Carolina.	H. A. Pressey	5.95	649.0
Aug. 25	McClure's bridge, North Carolina	N. C. Curtis	23.43	220.0
Oct. 18	do	do	22.67	434.0
1901.				
Aug. 9	do	do	20.8	683.5
1900.				
Aug. 22	Near mouth of Buffalo Creek, North Carolina.	do	15.2	57.1
Oct. 6	do	do	14.59	145.4
1901.				
Aug. 10	Near Chimney Rock, N. C.	do	14.1	247.6
1900.				
Aug. 21	Bridge at Batcave, N. C.	do		50.1
Do.	do	do	10.15	48.0
Oct. 6	do	do	10.45	62.4

NOTE.—At regular stations of the Geological Survey gages are installed by which the rise of the river is measured, an increase in the gage height representing an increase in the discharge of the stream. This is true of all the measurements in the above table except those made near Alston and at Dellinger, where bench marks were established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. In the latter case, therefore, an increase in the gage height means a lowering of the water surface and a corresponding decrease in the discharge of the stream.

The average annual fluctuation of the river at its mouth and near Buffalo Creek is 10 feet; at Batcave it is 8 feet.

WATER POWERS.

Broad River rises at an elevation of 3,100 feet. The elevation at the junction of Broad and Green rivers is about 780 feet. The total length of this portion of the stream is about 40 miles and the difference in elevation 2,320 feet, making the average fall per mile 58 feet. The average fall per mile from its head to its junction with Hickory Nut Creek, at Batcave, is 125 feet. From Batcave to a half mile below the mouth of Pool Creek the fall is also 125 feet per mile, but from that point to the mouth of Green River the fall is only 8 feet to the mile. As far down as Batcave the stream has a flood plain of about 75 yards average width, with no very steep slopes on either side. Hickory Nut Creek, a small stream entering the river just above the mouth of Reedy Patch Creek, has an average fall of 175 feet per mile, and the latter stream a fall of 150 feet per mile.

The water power of the upper section of the river is excellent and has been very little developed. Rock ledges are numerous, and falls of 8 feet in 100 feet frequently occur. The only obstacle is the absence of good building sites. There are three mills between Batcave and Pool Creek, each having a working head of about 10 feet.

The distance between Poors Ford and Dellinger is 25 miles. The water powers, descending the stream, are, briefly, as follows: (1) Big Island Ford Shoals, 1½ miles below Poors Ford, having a vertical fall of 3 feet and a slope of probably 6 or 7 feet in 400 yards, with good rock bottom and natural abutments; (2) Durham Shoals, 6 miles below the mouth of Second Broad River, with a vertical fall of 7 feet, which could be increased to 12 feet at the wheel, and with excellent foundations for a dam and building; (3) Palmers Shoals, 1 mile below the mouth of First Broad River, with a fall of about 18 feet in a half mile (the south bank at these shoals is nearly level, but the rock cliff juts out prominently on the north bank); and (4) Hopper and Blanton shoals, where the river makes a horseshoe bend and the difference in elevation across the neck is said to be 30 feet, the short shoal on the lower side of the neck being known as the Hopper Shoal and the one on the upper side as the Blanton Shoal. The latter power could be developed by piercing the neck of the tunnel and damming the water at the Blanton Shoal.

TRIBUTARIES OF BROAD RIVER.

DISCHARGE MEASUREMENTS.

During the investigation the following measurements were made of the principal tributaries of Broad River, in order upstream:

Discharge measurements of tributaries of Broad River.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
1901.					
May 24	Enoree River	Greenville, S. C	N. C. Curtis	7.7	160.0
Do	Tiger River	14 miles east of Greenville	do	19.5	174.0
May 25	Pacolet River	Clifton, S. C	do	13.1	900.0
1900.					
Aug. 30	First Broad River	Near mouth	do	17.7	285.3
Oct. 10	do	do	do	16.2	266.4
Aug. 23	Puzzle Creek	do	do	6.70	10.0
Aug. 24	Robersons Creek	At mouth	do		24.0
Aug. 23	Hollins Creek	do	do	5.8	14.3
Do	Cathey Creek	do	do	3.35	42.0
Aug. 24	Cane Creek	1 mile above mouth	do	5.43	17.0
Do	Second Broad River.	Bridge on Rutherfordton-Morganton road.	do	7.35	55.0
Oct. 4	do	do	do	7.00	64.0
1901.					
Aug. 13	do	Iron bridge near Bostic Station	do	23.45	273.3
1900.					
Aug. 23	do	1½ miles east of Forest City	do	20.8	153.3
Oct. 5	do	do	do	20.32	188.3
Aug. 31	Whiteoak Creek	One-half mile above mouth	do	4.65	64.0
Sept. 3	Cove Creek	Near mouth	do	5.40	19.2
Do	Green River	Near Saluda, on Howard Gap road	do	17.7	74.1
Aug. 25	do	Cox's bridge	do	22.9	299.0
Oct. 8	do	do	do	22.6	255.4
1901.					
Aug. 9	do	do	do	21.0	833.2
Aug. 25	Maple Creek	Near mouth	do	7.70	8.4
Do	Mountain Creek	do	do	6.83	55.3
Oct. 8	do	do	do	6.48	70.2
Aug. 22	Cove Creek	Bridge at Rutherfordton road	do	18.65	69.3
Oct. 6	do	do	do	18.16	86.0
Aug. 22	Buffalo Creek	15 yards below main ford	do	4.10	17.0
Aug. 21	Reedy Patch Creek.	At mouth	do	5.75	13.0
Do	Hickory Nut Creek.	do	do	4.80	15.2

NOTE.—In making the measurements recorded in the above table bench marks were established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. An increase in the gage height, therefore, means a lowering of the water surface and a corresponding decrease in the discharge of the stream, the reverse of the results at the regular stations of the Survey, where gages are installed and where an increase in the gage height represents an increase in the discharge of the stream.

Brief descriptions of the drainage basins and water powers of the three largest tributaries are given on the following pages.

FIRST BROAD RIVER.

This tributary rises on the southern slopes of the South Mountains, in the northern part of Cleveland and Rutherford counties, N. C., and flowing south joins Broad River about 8 miles south of Shelby, N. C. It drains an area of 302 square miles. The fall between the

crossing of the railroad from Shelby to Rutherfordton and the mouth of the stream is about 105 feet, or at the rate of 8 feet per mile. The width of the stream at its mouth is about 90 feet.

The water powers on the First Broad are as follows: Ten miles north of Shelby and 3 miles north of the Double Shoals, where is located Cleveland cotton mill No. 2, which contains 4,224 spindles and is run by water power exclusively, a fall of 13 feet being utilized. At the Double Shoals there is a cotton factory which contains 2,000 spindles run by water power. The dam is 9 feet high, giving a total fall of 15 feet. Three miles southwest of Shelby are the Lauraglen cotton mills, containing 3,500 spindles operated entirely by water power. The dam is 14 feet high and 200 feet long, the fall of water at the mill 15 feet. Chambers's gristmill, still farther downstream, utilizes a fall of 9 feet, though more is available—the stream at this point will probably afford 7 or 8 horsepower per foot of fall in the low season of dry years. Stices's Shoal, about 4 miles from the mouth of the river, has a natural fall of 6 feet in a distance of 80 feet over a smooth rock bed, with considerable fall below. By the construction of a dam across the upper part of this shoal the fall could be increased still more. The Buck McSwain Shoal is about 1 mile above the mouth of the river, and has a natural fall of 3 feet in 150 yards.

SECOND BROAD RIVER.

This stream rises on the southern slopes of the South Mountains, in McDowell County, N. C., about 10 miles directly south of Marion. It flows in a southerly direction, meeting Broad River about 8 miles below the confluence of Broad and Green rivers. It drains an area of 193 square miles, and has a total length of about 50 miles. The elevation of its headwaters is 1,500 feet, of its mouth about 700 feet, giving an average fall per mile of 16 feet.

Comparatively little clearing has been done around the headwaters of either Second Broad River or Cove Creek, a tributary of Broad River which rises near the Second Broad and drains a considerable portion of the southern slopes of the South Mountains. The proportion of cleared land here is estimated to be about 10 per cent of the entire area. Lower down, however, along Cathey and Robersons creeks, the amount of cleared land is much greater, probably 50 or 60 per cent of the whole. After leaving the South Mountains the river flows through a region of low, rolling foothills. The timbered areas are thinly covered, the trees being chiefly pines and scrub oaks. The soil is rather compact, of a light-yellow color, and not particularly rich, and permits fairly good roads to be constructed without much difficulty.

Rutherfordton, the county seat of Rutherford County, about 6 miles west of the Second Broad, is on the western boundary of the cotton belt. The farming lands of Cleveland County and the eastern

half of Rutherford County are mainly devoted to the production of cotton. Some sorghum cane also is raised, and the farmers usually make enough molasses for their own consumption. As the headwaters of the Second Broad and Cove Creek are approached the soil increases in fertility. The Cove Creek Bottoms are especially adapted to the production of corn, and along the slopes of the South Mountains tobacco is easily grown. The climate of the region is salubrious, and very little sickness prevails at any season of the year.

The waters of the First Broad and the Second Broad are never clear, even after protracted droughts, but are a sort of light-brown or yellow-ochre color. This is due to the character of the soil and to the extensive clearing which the watersheds have undergone. The beds of both streams are sandy except where rock shoals occur.

There are four cotton mills in operation in the Second Broad River region. The motive power of two of them is supplied by steam and of the other two by water. One of the steam mills is at Rutherfordton and the other at Forest City. The two water-power mills are known as Henrietta No. 1 and Henrietta No. 2. The former is 6 miles above the mouth of the river, at High Shoals, the latter about 7 miles above the mouth, at Caroleen. Both factories are connected with the Seaboard Air Line Railroad by branch lines. Henrietta mill No. 2 occupies the shoals formerly known as Harrells Shoals and Old Burnt Factory Shoals. A masonry dam about 24 feet in height gives a fall at the wheel of 29 feet. The natural fall of the shoals is 18 feet. The mill contains 35,000 spindles and 1,000 looms. At Henrietta mill No. 1 the natural fall is 23 feet, but a stone dam, slightly curving upstream, 17.8 feet high, gives a fall at the wheel of 32 feet. This dam is 200 feet long. The race is 300 feet long, 35 feet wide, and 10 feet deep. The mill operates 25,000 spindles and 1,000 looms. Both factories have auxiliary steam plants, and seem to have been extremely successful and profitable to their owners. The cotton used is raised in the immediate vicinity and hauled to the mills on wagons. About 2 miles from the mouth of the river the stream makes a long curve, the hillsides closing in very close to either bank. A site has been surveyed here for a large mill, and land has been cleared and construction begun. The natural fall between this site and Henrietta mill No. 1 is about 40 feet. A dam 23 feet high is to be built. No race is to be constructed, but the wheels are to be located at the dam. The fall below the shoals is abrupt for a short distance, and the waste water will flow off readily. The building site is fairly good. This dam will destroy the water power of Tumbling Shoals, 3 miles above the mouth of the river.

GREEN RIVER.

Green River rises in Henderson County, near the Transylvania County boundary line, on the northwestern slopes of the Saluda Moun-

tains. The elevation of its headwaters is 2,900 feet, of its mouth 780 feet, the difference in elevation being 2,120 feet. The total length of the river is about 45 miles, making the average fall per mile about 47 feet. The distance from its head to the point where it emerges from the Blue Ridge is 23 miles, and the difference in elevation between the two points 1,800 feet, making the average fall per mile in that section 78 feet. The length of the remaining section is 22 miles and the difference in elevation 320 feet, making the average fall per mile only 15 feet. The drainage area is 198 square miles.

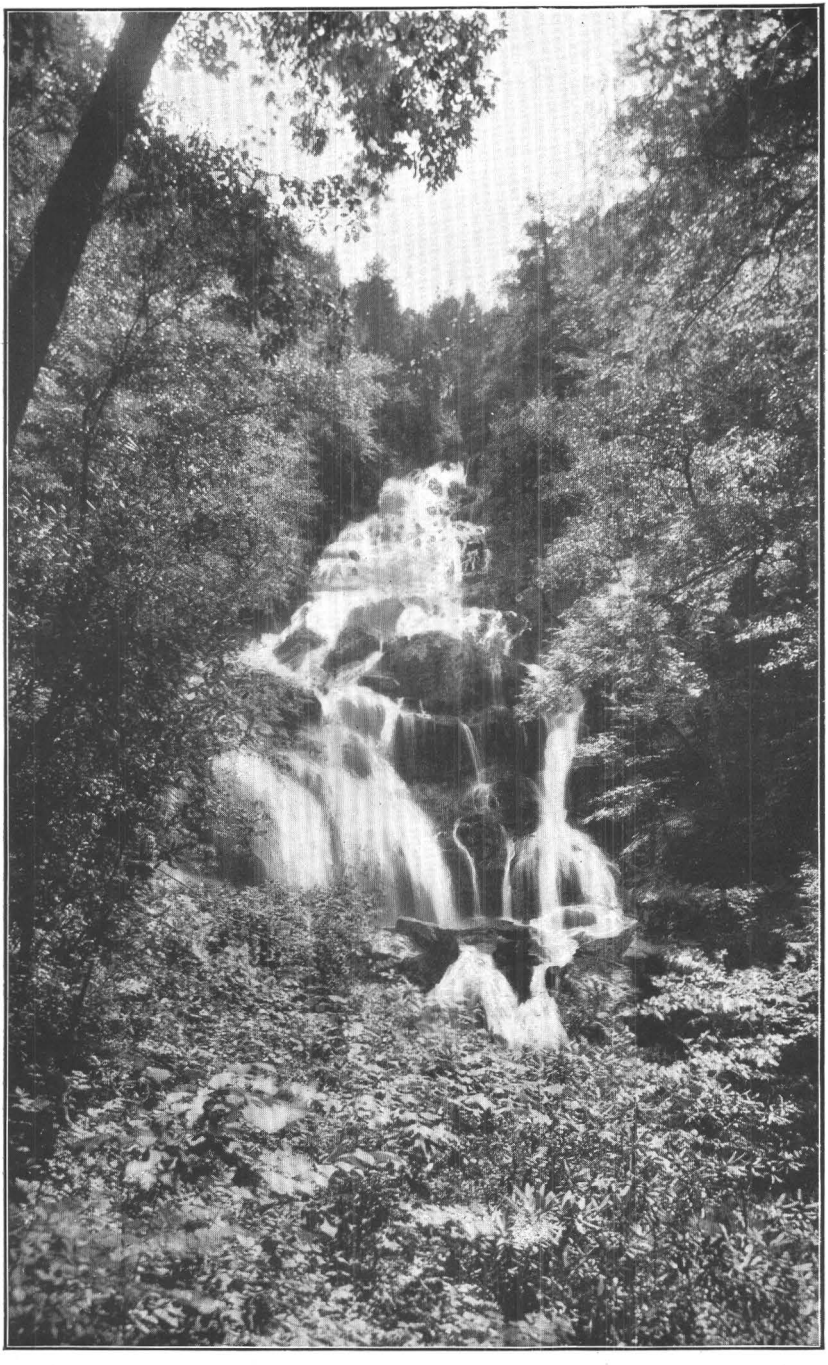
Along the upper portion of the river the mountain slopes shut in very close, and the timber on the watersheds is practically untouched. Consequently the flow of the stream is constant and the water always clear and cold. The scenery up Green River Cove and around Saluda while beautiful is not remarkably grand. The two most conspicuous mountain peaks are Whiteoak and Tryon. The latter has an elevation of about 3,200 feet.

Between Zirconia and the mouth of Cove Creek the river flows in a narrow gorge. The water power of this section is excellent, but building sites are scarce. The two water powers which are considered among the best on the stream were visited. The first of these, the Pot Shoals, is about 2 miles below the Southern Railway bridge. The fall consists of a drop of 8 feet and a total fall of possibly 30 feet in 100 feet. There is a fairly good site for a building here and excellent facilities for constructing a dam. The next power is at The Narrows, about 4 miles below the Pot Shoals. Here the stream is forced to pass through a narrow and rocky channel 7 feet wide and 50 feet long. The fall is about 10 feet in 100 feet. Building facilities are poor. Another power on the river, known as the falls of Green River, is not so well located as are the Pot Shoals. Here "the fall is about 30 feet in 100 feet, preceded by rapids for three-eighths of a mile, making a total fall of 45 feet. The banks are rocky and very steep, so that building facilities are not good." On the whole, the water powers of Green River are better than those of the Upper Broad, but they are not so accessible, and the building sites are poor. The average annual fluctuation of the river at its mouth is 11 feet; near Saluda it is 9 feet.

The healthfulness of the Green River region is unexcelled. Saluda and Tryon, situated on the Asheville and Spartanburg division of the Southern Railway, are popular summer and winter resorts.

Great expectations are entertained of the deposits of zircon in the valley of Green River.

The side streams flowing into Green River are mostly short, but have heavy falls. Whiteoak Creek is the only tributary of importance. Its fall, however, is small, but it has a very wide flood plain. The bottom land is well cultivated, mostly in corn. The soil is loamy and rich. The average fall is about 12 feet to the mile; the average annual fluctuation 10 feet.



FALLS ON UPPER CATAWBA RIVER, NORTH CAROLINA.

CATAWBA RIVER.

PHYSICAL FEATURES.

This river rises near the Buncombe and McDowell county line in North Carolina, and flows almost due east through McDowell and Burke counties and between Alexander and Catawba counties, where it turns to the south and finally enters South Carolina near the Mecklenburg-Gaston-York county line. After a course of about 160 miles in South Carolina it joins the Congaree to form the Santee. Below the mouth of Big Wateree Creek the river is known as Wateree River. Its drainage area in North Carolina is 3,085 square miles. Its total drainage area is 5,225 square miles.

The Catawba receives its headwaters from the southeastern slopes of the Blue Ridge, the main stream rising at the junction of the latter mountains with a spur known as the Edmondson Mountains. At Oldfort the waters of Mill Creek, with its branch, Jarrett Creek, are added to the Catawba, forming a river of considerable size. The drainage basins of these streams are decidedly mountainous, with steep, wooded slopes. The streams are swift mountain torrents, with large falls and great fluctuations of discharge. The flow at times of low water, however, is fairly large. On Catawba River above Oldfort there are precipices many feet in height, over which the river plunges in its descent toward the Piedmont Plain. (See Pl. XXXV.) In the first 6 miles of its course the river falls 1,500 feet. Below Oldfort the character of the drainage basin changes, becoming very like that of the Yadkin, described on pages 158 to 164. The valley broadens out, especially on the south side of the river, the land immediately contiguous to the stream being flat or gently rolling. The Blue Ridge is not far distant, however, extending to the northeast, with frequent ridges projecting toward the Catawba, between which flow the numerous northern branches of the stream. The tributaries from the north are Curtis, Crib, Clear, and Buck creeks, North Fork, Paddy Creek, Linville River, Cane Creek, Upper Creek, John River, and Lower Creek. These streams for the most part receive their waters from either the Blue Ridge or the Linville mountains, and in their upper courses run between parallel ridges with steep slopes heavily wooded. In their lower courses they reach the Piedmont Plain, where the fall becomes less and their valleys more open, being generally cultivated to some extent.

The river receives several tributaries from the south between the source of the stream and Morganton. The chief of these are Crooked Creek, Muddy Creek, and Silver Creek, meandering, comparatively slow-flowing streams, with a large part of their drainage areas under cultivation.

The reconnaissance of the drainage basin of Catawba River extended only from its headwaters to Morganton, N. C., that being the portion of greatest interest in connection with the studies of the proposed Southern Appalachian Park. Below Morganton the river receives a number of large tributaries and has many water powers in its course across the Piedmont Plain, but they were not visited.

RAINFALL.

The average rainfall in the basin of the Catawba is about 50 inches, distributed as follows: Spring, 12 inches; summer, 14 inches; autumn, 10 inches; and winter, 14 inches. Toward the upper part of the stream, however, the rainfall in winter increases, and is probably greater than in summer.

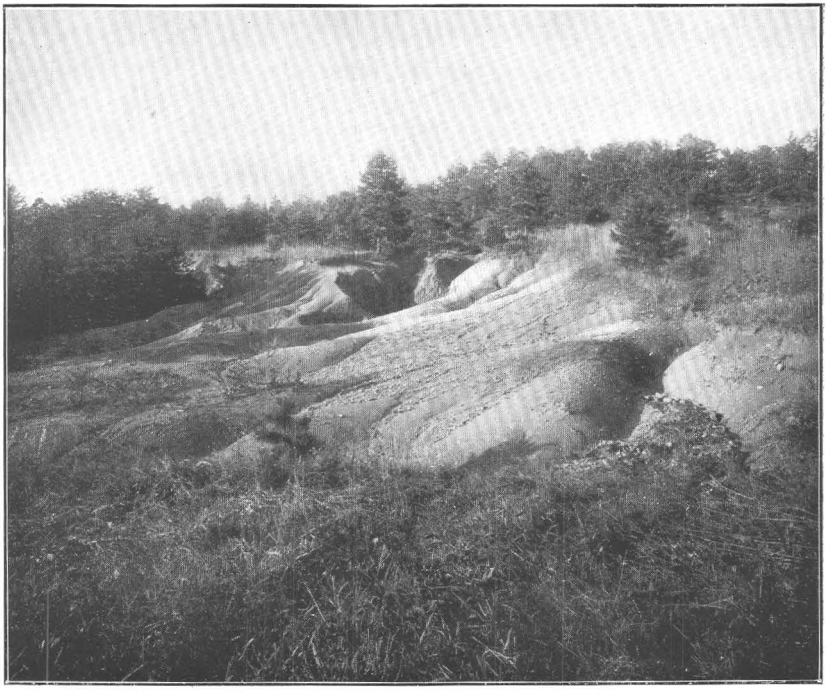
FORESTS.

The region of the headwaters of the Catawba and its chief branches, which flow from the steep slopes of the Blue Ridge, is heavily forested. At the foot of the mountains the timber consists of beech, poplar, linn, oak, and ash, changing to pines as the slopes are ascended, and near the summits to balsam fir. In the broad valley of the main stream a large part of the land has been cleared and is now used for agricultural purposes. The soil is deep and fertile, the top soil being largely flood deposits of the river. When the forests are cleared from the bases of the steeper mountain slopes considerable difficulty is experienced from the washing away of the top soil, leaving only the barren subsoil or clay beneath. This wash is often so extensive as to completely destroy large areas of land. Pl. XXXVI shows the effect of deforesting areas which can not properly be protected from this agency.

The banks of the Catawba are subject to overflow during the highest floods, and great damage is often caused. It is not uncommon for a fine stretch of farming land to be completely ruined in a single day by the high waters washing away the soil down to the bottom clays or gravels. (See Pl. XXXVII, *A*.) It has been estimated that in the drainage basin of the Catawba a single flood has caused damage to the extent of a million dollars. (See Pl. XXXVII, *B*.) That these floods are checked to some extent by the forests there can be no doubt; and in the absence of other regulators, such as lakes or marshes, the forests on the mountain sides form the only protection that the people dwelling in the valleys below have from the violence of flood waters.

DISCHARGE MEASUREMENTS.

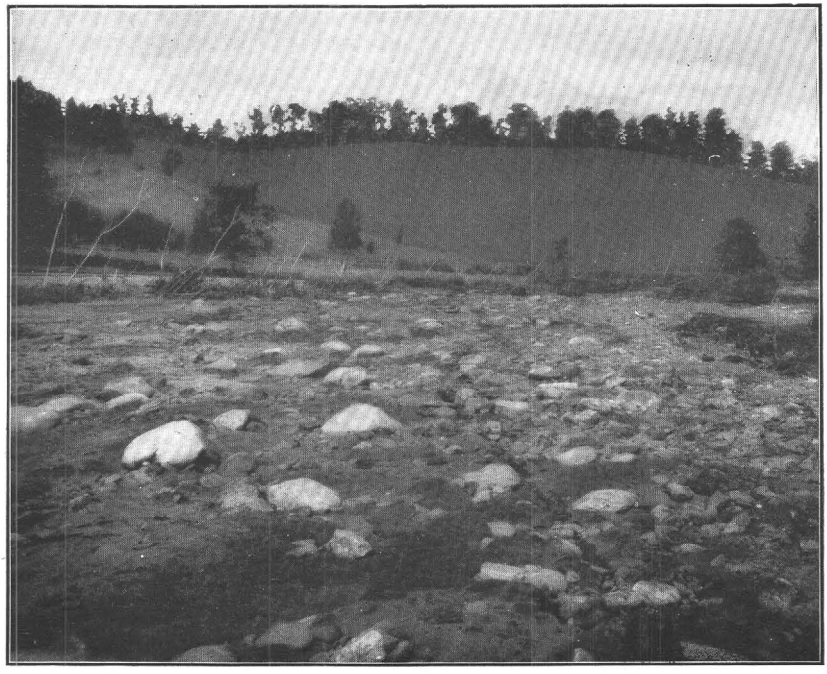
During the investigation temporary gaging stations were established on Catawba River near Morganton, on John River near Morganton, and on Linville River near Bridgewater. For several years the



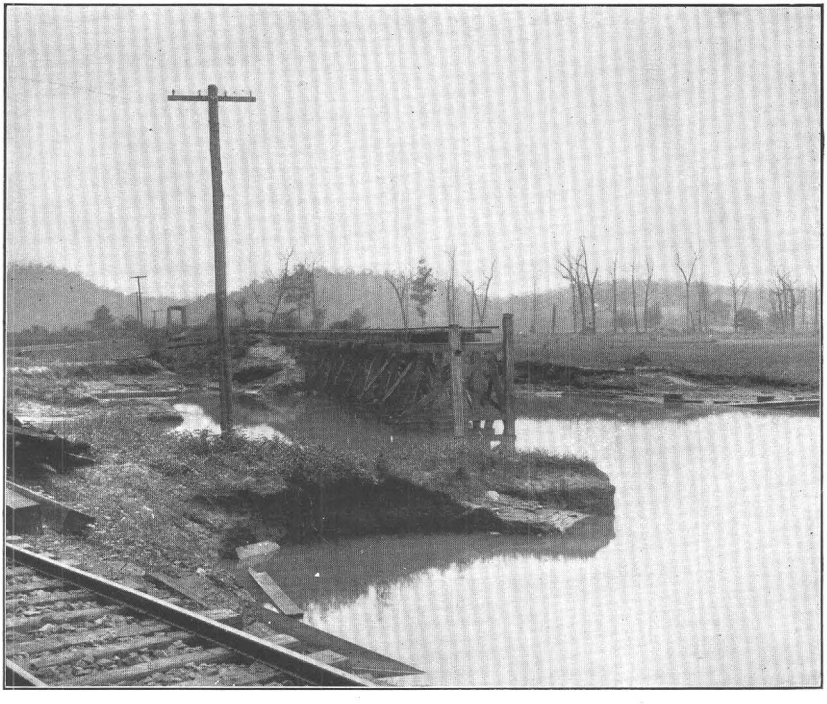
A.

B.

VIEWS SHOWING HILLSIDE WASH IN VALLEY OF CATAWBA RIVER.



A. VIEW SHOWING REMOVAL OF SOIL IN VALLEY BY FLOODS.



B. VIEW IN VALLEY OF CATAWBA RIVER, SHOWING DESTRUCTION BY FLOODS.

Survey has maintained two stations on the Catawba River—one at Catawba, N. C., and the other at Rockhill, S. C.—the results of which have been published in the annual reports. The results of all measurements made on the river during the investigation are contained in the following table; the results of measurements on the tributaries in the table on pages 151 and 152.

Discharge measurements of Catawba River.

Date.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.			*Feet.*	*Sec.-feet.*
Feb. 21	Rockhill, S. C.	E. W. Myers	2.63	3,803
Feb. 22	do	do	5.28	16,791
Apr. 13	do	do	2.75	4,703
Apr. 21	do	do	9.07	31,610
May 21	do	do	2.42	3,703
July 4	do	do	2.86	5,623
Aug. 16	do	do	1.79	1,936
Oct. 26	do	do	3.30	8,843
1901.				
Apr. 4	do	do	9.80	33,150
Apr. 23	do	do	4.65	10,314
May 23	do	do	[a]24.15	150,783
July 20	do	do	2.00	3,822
1900.				
July 3	Catawba, N. C.	do	3.45	3,372
Aug. 14	do	do	2.10	914
Nov. 7	do	do	2.95	2,083
Dec. 18	do	do	2.59	2,139
1901.				
Mar. 29	do	N. C. Curtis	5.83	5,640
Apr. 27	do	E. W. Myers	4.37	4,354
July 25	do	do	2.95	2,805
1900.				
June 13	Near Morganton, N. C.		1.33	1,393
June 18	do		2.50	4,030
July 6	do		1.30	1,164
Aug. 8	do		0.60	558
Sept. 24	do		0.50	525
Nov. 7	do		1.50	1,374
June 28	Oldfort, N. C.	H. A. Pressey	10.10	53
Aug. 20	do	N. C. Curtis	12.70	11
Sept. 20	do	do	12.78	12

[a] Greatest flood ever known on river.

NOTE.—At regular stations of the Geological Survey gages are installed by which the rise of the river is measured, an increase in the gage height representing an increase in the discharge of the stream. This is true of all the measurements in the above table except those made at Oldfort, where a bench mark was established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. In the latter case, therefore, an increase in the gage height means a lowering of the water surface and a corresponding decrease in the discharge of the stream.

The following table, computed by E. W. Myers, shows the comparative minimum flows of Catawba River at the Catawba and Rockhill stations, which are about 60 miles apart, for the years 1895 to 1899. The drainage area at Catawba is 1,535 square miles and at Rockhill 2,987 square miles. Comparing this table with a similar one for Yadkin River, published in Water-Supply Paper No. 36, page 119, it will be seen that the run-off per square mile does not vary more than would be expected. The Catawba station was established in 1896, the Rockhill station in 1895.

Table showing comparative minimum flows of Catawba River at gaging stations at Catawba, N. C., and at Rockhill, S. C.

Year.	Driest month.		Mean flow for driest month.		Mean flow per square mile for driest month.		Minimum flow for year.		Minimum flow per square mile for the year.	
	Rockhill.	Catawba.	Rockhill.	Catawba.	Rockhill.	Catawba.	Rockhill.	Catawba.	Rockhill.	Catawba.
			Sec.-ft.	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
1895	Sept [a]	----------	1,318	----------	0.441	----------	1,300	----------	0.435	----------
1896	Aug	Oct	1,604	865	.54	0.56	[b] 1,330	770	.445	0.501
1897	Sept	Sept	1,817	1,017	.61	.66	[c] 1,575	[d] 850	.526	.553
1898	June	June	2,091	1,069	.70	.69	1,600	910	.535	.592
1899	Nov	Nov	2,492	1,340	.835	.873	2,300	1,220	.770	.793

[a] Seven days' record.
[b] Also in July, August, and September.
[c] Minimum occurred in January. September minimum was 1,700 second-feet, or 0.569 second-foot per square mile.
[d] Minimum in October. September minimum 900 second-feet, or 0.579 second-foot per square mile.

WATER POWERS.

Between Morganton and the mouth of Mill Creek, a distance of 50 miles, there are 197 shoals with an average fall of about 2 feet. In McDowell County the fall of the river is very great, there being in one or two cases vertical drops of 100 feet, but the channel is so narrow that the power is not of great value for development. Rock Ford Shoal, at Morganton, has a natural fall of 9½ feet in a distance of about 1,500 feet.

Although the investigation embraced only the portion of the drainage basin above Morganton, as some of the chief water powers of the river are below that place they will be mentioned in this connection. Briefly described, they are as follows:

Devil Shoal has a fall of 14 feet in a distance of 1 mile, and is well located for improvement. Horseford Shoal, 3 miles north of Hickory, has a fall of 31 feet in 2.9 miles; the power is utilized to only a limited extent. The Great Fall Shoals have a fall of 14.8 feet in a distance of 1 mile. Canoe Landing Shoal, about 2 miles above the mouth of Lower Little River, has a fall of 8.9 feet in a distance of 1.87 miles. The Lower Little River Shoals are between the upper end of Druin Island and the lower end of Three-Cornered Island, with a fall of 9.7 feet in a distance of 1.16 miles. Lookout Shoal, about 6 miles above Catawba Station, has the greatest fall of any shoal on the river in North Carolina, the descent being 54.25 feet in a distance of 3.2 miles. About 30 feet of this fall is said to occur in a distance of three-fourths of a mile. The Buffalo Shoals have a fall of 11.4 feet in a little more than a half mile; they are a short distance below the Western North Carolina Railroad crossing. Long Island Shoal, about 7 miles southeast of Catawba Station, has been improved and a cotton factory constructed to utilize the power. Monbo Shoal is utilized by a cotton mill. Beatties Ford Shoal has a fall of 13 feet in 2.38 miles, and

Cowan Ford Shoal a fall of 27 feet in a distance of 4.17 miles. Mountain Island Shoal is utilized to a small extent by a cotton factory containing 6,300 spindles and using a fall of 22.5 feet. Tuckasegee Shoal, about 9 miles above the State line, has a natural fall of 11 feet in a distance of 1 mile, and is utilized by a cotton mill of 6,000 spindles. Near the State line there are several shoals with falls of from 3 to 5 feet, some of which have been used to a limited extent, but considerable difficulty has been experienced from high water.

TRIBUTARIES OF CATAWBA RIVER.

DISCHARGE MEASUREMENTS.

During the investigation the following measurements were made of the important tributaries of the Catawba above Morganton, N. C., in order downstream:

Discharge measurements of tributaries of Catawba River.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
June 28	Mill Creek	Oldfort	H. A. Pressey	3.85	85.0
Aug. 20	do	do	N. C. Curtis	6.73	27.0
Sept. 20	do	do	do		13.0
June 28	Jarrett Creek	Near Oldfort	H. A. Pressey		17.0
Do	Curtis Creek	200 feet above ford of Oldfort road.	do		82.11
Aug. 20	do	do	N. C. Curtis		16.50
June 28	Crib Creek	Near ford of main road	H. A. Pressey	4.9	28.03
Aug. 28	do	do	N. C. Curtis		10.0
June 28	Clear Creek	200 feet above ford of main road.	H. A. Pressey		25.25
Aug. 28	do	do	N. C. Curtis		12.0
June 14	Buck Creek	½ mile above mouth, at main ford.	H. A. Pressey		51.91
Aug. 20	do	do	N. C. Curtis	5.35	41.4
July 3	North Fork of Catawba River.	First ford above mouth	H. A. Pressey		240.2
Aug. 18	do	do	N. C. Curtis		67.3
Sept. 21	do	do	do	3.18	61.69
June 15	Turkey Cove Creek	Just above second ford	L. V. Branch	5.75	21.48
June 26	do	do	do	5.30	164.8
June 14	Muddy Creek	Bridgewater	H. A. Pressey	5.80	161.9
June 16	do	do	L. V. Branch	4.1	618.0
July 10	do	do	do	6.0	119.2
Aug. 17	do	do	N. C. Curtis	6.43	98.6
Sept. 21	do	do	do	6.34	101.7
June 14	Paddy Creek	Near Bridgewater	H. A. Pressey	11.3	19.78
June 16	do	do	L. V. Branch	5.4	203.67
July 10	do	do	do	11.55	11.5
Aug. 17	do	do	N. C. Curtis	12.35	7.0
June 21	Linville River	Linville	H. A. Pressey	14.83	21.0
June 24	do	do	do	14.23	90.22
June 14	do	Near Bridgewater		9.92	104.0
July 3	do	do		9.54	216.0
July 10	do	do		9.90	116.0
Aug. 17	do	do		10.15	78.0
Sept 21	do	do		9.8	55.0
June 14	Cane Creek	Lowest ford of main Morganton road.	H. A. Pressey	5.72	18.58
June 18	do	do	L. V. Branch	5.85	28.45
Aug. 17	do	do	N. C. Curtis	6.3	7.2
June 14	Silver Creek	Near Morganton	L. V. Branch	6.84	124.0
Aug. 10	do	do	N. C. Curtis	8.30	48.4
Sept. 24	do	do	do	8.20	56.0
1901.					
June 14	do	do	E. W. Myers	13.08	995.0

Discharge measurements of tributaries of Catawba River—Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
June 13	Upper Creek	¼ mile above mouth	N. C. Curtis	2.2	182.4
July 6	do	do	L. V. Branch	2.3	50.0
Aug. 8	do	do	N. C. Curtis		85.05
Sept. 24	do	do	do		60.0
June 20	do	Ford at Henderson's mill	H. A. Pressey	12.9	20.42
Do.	do	Upper Creek Falls	do		27.0
Do.	Steel Creek	Footbridge 100 yards above mouth.	do	3.20	100.21
Sept. 25	John River	Collettsville	N. C. Curtis	4.77	40.0
Nov. 6	do	do	do	4.47	135.0
June 13	do	Near Morganton		2.64	465.0
June 19	do	do		3.50	1,202.0
July 6	do	do		2.63	511.0
Aug. 8	do	do		1.90	135.0
Sept. 24	do	do		1.90	148.0
Nov. 7	do	do		2.32	367.0
Sept. 25	Mulberry Creek	At mouth	N. C. Curtis	7.85	17.0
Nov. 6	do	do	do	7.95	39.0
Do.	Wilson Creek	do	do	0.75	208.0
June 13	Lower Creek	2 miles above mouth	E. W. Myers	14.58	209.0
July 6	do	do	L. V. Branch		132.0
Aug. 8	do	do	N. C. Curtis		69.0
Sept. 24	do	do	do	15.38	56.0

NOTE.—At regular stations of the Geological Survey gages are installed by which the rise of the river is measured, an increase in the gage height representing an increase in the discharge of the stream. This is true of the measurements in above table of John River near Morganton and of Linville River near Bridgewater. In making all of the other measurements, however, in each case a bench mark was established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. In these cases, therefore, an increase in the gage height means a lowering of the water surface and a corresponding decrease in the discharge of the stream.

The principal tributary drainage basins and water powers are briefly described on the following pages.

CENTER, CRIB, AND CLEAR CREEKS.

Of the tributaries from the north, Center, Crib, and Clear creeks have drainage areas of a similar character. There is considerable fall near their sources, which gradually becomes less as the streams are descended, the valleys broadening out and being partially cultivated. About three-fourths of the drainage areas are forest-covered. The streams are too small for extensive water-power development, but two small gristmills have been built on Crib Creek. The low-water flow of the stream is so small, however, that the mill can not be run during the dry season.

BUCK CREEK.

This creek rises in Buck Creek Gap, and has a drainage basin similar to the creeks just described, though much larger. The fall is very great along its upper course. Six miles from its mouth are the falls of Buck Creek, with a vertical drop of 12 feet. A rough and rocky highway, leading from Marion through Yancey County, follows the stream throughout its course. The scenery near the gap is very fine. Two mills have been constructed, and are run during a part of the year. Near the mouth of the creek there are some

good farms. About a quarter of a mile above the mouth the Marion-Oldfort road crosses the creek. Here measurements were made of the discharge (see table on page 151).

NORTH FORK OF CATAWBA RIVER.

This stream enters the Catawba near Marion. At its headwaters it is a mountain stream with very heavy fall, draining the narrow valley between the Blue Ridge and the Linville mountains. The mountain slopes are covered with a valuable growth of timber, practically no cutting having been done on them. About 7 miles downstream the valley broadens slightly and furnishes a very fertile soil excellent for agricultural purposes. This valley land has been cleared and is now largely in grain or grass. About three-fourths of the drainage area is still in forest. Two small combined gristmills and sawmills have been built on the stream, with falls of 6 and 8 feet. Turkey Cove Creek, a branch of the North Fork, is a mountain stream of considerable fall, with wooded slopes. The total drainage area of the North Fork is 835 square miles.

PADDY CREEK.

This creek has the same general characteristics as the other northern tributaries of the Catawba in the region. Its headwaters are on the steep slopes of the Linville Mountains, and its lower course is across the Catawba Valley. Its watershed is long and narrow, being close to Linville River on one side and flowing nearly parallel to the Catawba on the other.

LINVILLE RIVER.

This river is formed by a number of small streams which head on Grandfather and Sugar mountains and in Linville Gap. The sources of most of the streams are large springs, which are numerous throughout the region, furnishing perfectly clear and chemically pure water. Grandfather Mountain has an elevation of 5,964 feet; the heads of most of the streams rising upon its slopes are at an elevation of 5,000 feet. The elevation of Sugar Mountain is 5,289 feet, while Linville Gap, between these two high peaks, has an elevation of 4,097 feet. Four miles south of Grandfather Mountain is Grandmother Mountain, elevation 4,686 feet, upon which rises Grandmother Creek, which flows into Linville River 1 mile below the village of Linville.

The mountain slopes are steep and rocky, the small streams falling in a series of cascades. The virgin growth of timber is still on the mountain sides and extends to the summits, practically no cutting having been done. Three miles below Linville, at Pineola, there is a healthy growth of white pine, but from Linville upstream the river is above the white-pine belt, the growth changing to spruce, chestnut,

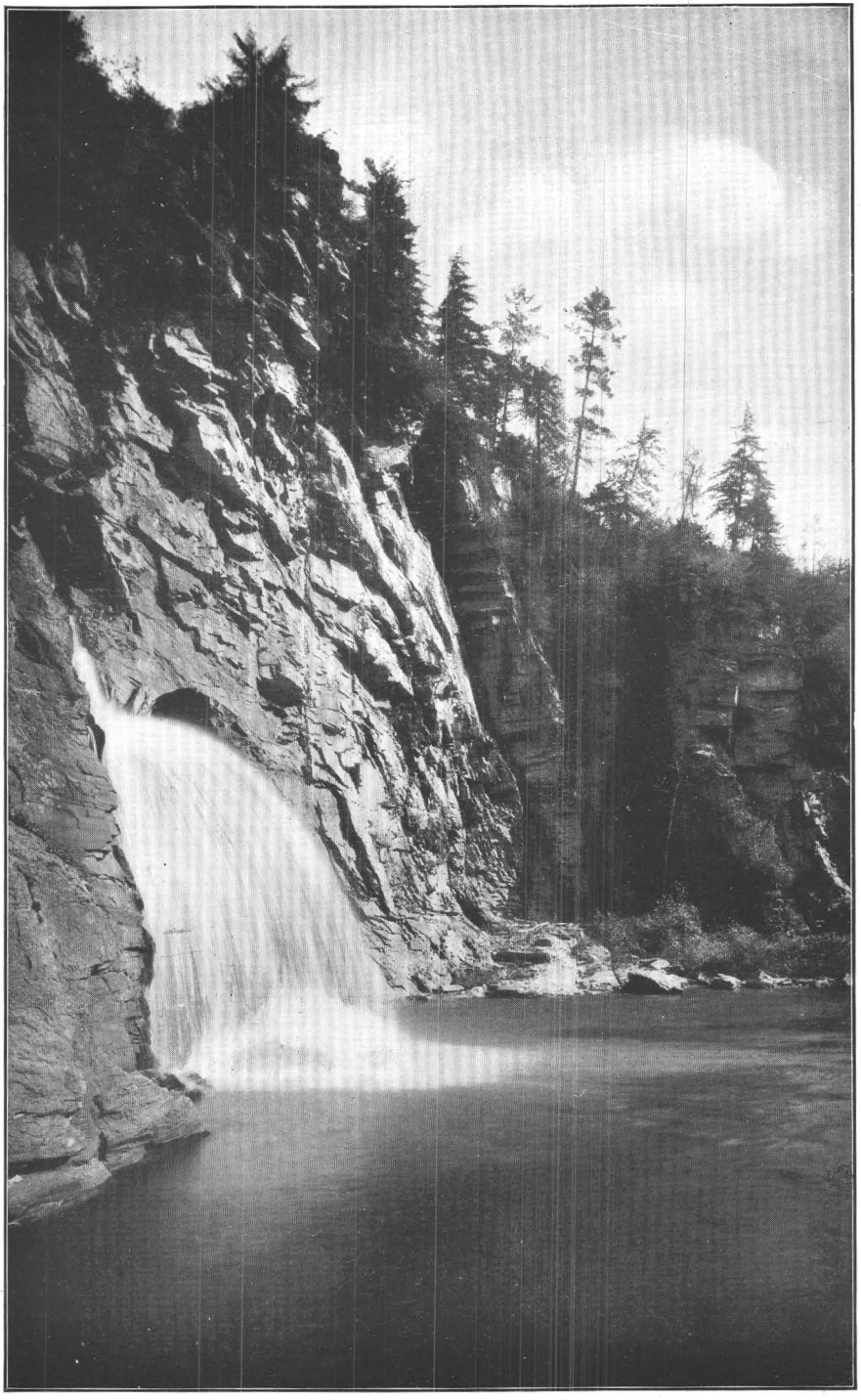
white and red oak, poplar, linn, ash, buckeye, birch, beech, cherry, and, on the highest elevations, balsam fir. The temperature is usually low, frosts having been known to occur in each month of the year.

Below Grandmother Creek the river has no tributaries of any size. From Grandfather Mountain to Linville Falls its valley is narrow, the land on both banks rising abruptly to the mountain summits, permitting only short tributaries and a narrow drainage area. Linville, a village of about thirteen houses and a summer hotel, is between the river and Grandmother Creek, on a comparatively flat area, and Pineola, 3 miles below, a village built up largely during 1900, occupies another flat section.

The falls of the Linville, located near the Mitchell-Caldwell-McDowell County line, have an aggregate fall of 90 feet in four clear leaps. The first fall is 50 feet upstream from the main fall, and is a vertical drop of 15 feet. There are then three drops in quick succession of 25, 10, and 40 feet, respectively. The water at the last drop (see Pl. XXXVIII) falls in one sheet into a still pool, from which it flows through a narrow gorge 10 miles long between Gingercake Mountain, Hawks Bill, Table Rock, and Shortoff Mountain on the east and the Linville Mountains on the west. The walls of this gorge are precipitous, in many places almost vertical, and rise to heights of from 500 to 2,000 feet. Through it the Linville has no tributaries, receiving only the water which falls on the steep slopes and the flow from the springs on the mountain sides. It may well be considered one of the greatest mountain features of the region. The high and rocky walls are so close to the river that there is no space for highway or railroad. In fact it is with the greatest difficulty that one can make his way through the chasm, jumping from rock to rock, clinging to rocky ledges, and in places where no foothold is offered on either side wading the stream. The scene is grand and inspiring, viewed either from the chasm, where immense vertical rocky cliffs rise on either hand, showing nothing beyond but the blue sky, or from the upper edge of the gorge, where one can look vertically down several hundred feet and see the rapid, sinuous stream cutting its way to the valley below.

At Linville Falls, at the upper end of the chasm, the drainage basin of the main stream and its tributaries has an area of 50 square miles. The next 10 miles of the course of the river is through the gorge. After emerging from the rocky walls of the chasm it flows for 8 or 9 miles as a comparatively quiet stream through Birch Bottom and Catawba Valley, finally joining its waters to Catawba River.

At Linville records of rainfall have been kept by the United States Weather Bureau for nearly eight years. These records show that the annual precipitation is about 46 inches, distributed as follows: Spring, 11.50 inches; summer, 13.50 inches; autumn, 9.50 inches; and winter, 11.50 inches. The climate is pleasant and very healthful, so that



LOWER FALLS OF LINVILLE RIVER, NORTH CAROLINA.

numerous summer visitors take advantage of the excellent hotel accommodations at Linville, at the foot of Grandfather Mountain.

There are opportunities for development of water power on the Linville and its tributaries. On Grandmother Creek the Linville Improvement Company has built a timber-crib dam across the stream near its mouth, to form a fish and ice pond. The dam is 20 feet high, but its height could be increased and a small water-power plant installed. There is another site farther up the creek where a fall of 15 or 20 feet could be developed.

At Linville Falls, on the main stream, at the head of the gorge, considerable power could be developed, though the chasm is so narrow that there would be difficulty in finding space for buildings. From Linville Falls to the point where the river enters the flat plain of the Catawba Valley the fall of the river is large, with frequent drops of 3 or 4 feet. About 2 miles below Linville Falls, near Bynums Bluff, there is a fall of 5 feet, and 1½ miles farther down is what is known as Cascade Rock, where the river falls vertically 12 feet. From the foot of the falls to the Catawba Valley the fall of the river is about 1,800 feet. None of the power in the gorge or at the falls has been developed.

There are several small mills on the river. One mile above Linville there is a small sawmill and gristmill with an 8-foot timber dam, which has sufficient water to run throughout the year. Two miles above Linville Falls, at the mouth of Camp Creek, there is a sawmill and gristmill utilizing an 8-foot fall, and 1 mile above the falls there is a sawmill with a timber dam 10 feet high, a 46-inch turbine being used to run a circular saw. At the Franklin mill, a half mile above the falls, Pine Creek has a 10-foot fall, and power is furnished by overshot wheels and turbines. About 4 miles above the mouth of the river, at Berry's mill, an 11-foot head is utilized with a 4-foot home-made wheel, and 3½ miles lower down, at Pool's mill, a 9-foot fall is utilized for a gristmill run by a 20-inch and a 36-inch wheel. On July 3, 1900, a gage was established at the latter mill, and the miller reads the height of the river every day. Measurements of flow have also been made, the results of which are given in the table on page 151.

In ordinary years the river has a fluctuation of about 8 feet at Pool's mill, though on September 6 and 7, 1898, the water rose 18 feet in forty-eight hours. This is the highest stage known, but in 1882 there was a rise of about 17 feet.

CANE CREEK.

Cane Creek, flowing into the Catawba from the north, drains 16 square miles of comparatively flat and open country, much of which is under cultivation. There is very little fall in this stream. The measurements made are given in the table on page 151.

UPPER CREEK.

This stream, the next important tributary of the Catawba from the north, rises on Jonas Ridge and Cranberry, Cold, and Park mountains, at an elevation of about 4,000 feet. The sides of these mountains are for the most part steep and precipitous and are covered with a dense forest growth. The most common trees are chestnut, oak, white pine, and poplar. Very little of the original timber has been cut, though fires have spread over considerable areas, seriously injuring the forests. As the fires, however, were widely separated, both in time and in area, the drainage basin near the headwaters of the stream is almost entirely forest covered, either with the original timber or with a younger forest growth.

A large part of the regular flow of the creek is made up of effluents from springs, which are numerous on the mountain slopes. To this flow, however, is added the surface drainage from the mountain sides, which in the upper part of the creek reaches the stream quickly, so that during a rain the creek rises rapidly and falls soon after the rain ceases.

Throughout this and the neighboring watersheds will be found shady ravines, with springs breaking forth and adding their waters to other springs until a considerable stream is formed with a comparatively constant flow. The Piedmont Springs, 9 miles from the source of Upper Creek, have been celebrated for thirty years, and formerly many people from the Southern States visited them as a summer resort, being accommodated in a large hotel close at hand. The springs are charged with iron and soda. Though still flowing, they are not now much visited and the hotel has fallen into decay. About 2½ miles from the source of Upper Creek is Cold Water Spring, where a hotel has recently been built to accommodate summer visitors.

The fall of Upper Creek and its tributaries is very great from the headwaters down to Piedmont Springs. The two forks of the creek have a fall of 250 feet per mile to their junction. In the next mile there is a fall of 1,000 feet, largely made up of a series of small falls of from 5 to 10 feet. About one-fourth of a mile below the Cold Spring hotel there is a single fall of 90 feet. On June 20, 1900, the stream was measured a few feet above these falls, and the quantity flowing was found to be 27 second-feet. The low-water flow is probably about two-thirds that amount. The walls here are steep and rocky, with good natural abutments for a dam, though the fall is so great that the storage capacity would not be very large. About three-fourths of a mile above these falls there is a combined shingle mill, sawmill, and gristmill. An 8-foot dam has been built across the stream, giving an 18-foot head on the wheel—a Smith-Morgan turbine. A half mile farther down there is another small sawmill and gristmill. Between the main falls of Upper Creek and the gristmill there is a fall of at least 200 feet in a distance of three-fourths of a mile.

The low-water flow of the creek is quite large, owing to the many springs in its watershed and to its forested basin. From Jonas Ridge down to Joy the drainage area is completely covered with forest from the river bank to the summits of the mountains. The most common trees are chestnut-oak, white pine, and poplar. At Joy there is a small gristmill with a 6-foot timber dam, and a half mile below there is a gristmill and sawmill with a flow of about 8 feet over a timber dam, two 36-inch turbines furnishing the power. There is another gristmill on Upper Creek near the mouth of Irish Creek. From Joy to the mouth of Upper Creek the valley is wider and the hills bordering the watershed are comparatively low and flat, rising on either side about 100 feet above the stream. The hillsides are largely covered with forests, the growth extending to the banks of the creek. There are, however, open cultivated areas through the valley, the chief crops being corn and wheat. It is probable that two-thirds of the total drainage area of Upper Creek is forested.

Below Joy there are two mills—Turner's and Wakefield's. In the next mile there is a fall of about 25 feet, the ordinary high-water rise above the present stage being about 7 feet. Turner's mill is a gristmill and sawmill with a fall of about 8 feet, two 36-inch Smith-Morgan turbines being used. The 7-foot dam backs the water about a quarter of a mile. At lowest stages the water is about 6 inches lower than at the time of measurement, when the discharge was 20.42 second-feet. In 1898 there was unusually high water, the stream rising 16 feet. Three miles below Turner's mill is Caldwell's gristmill, owned by Mrs. W. C. Anderson. There is a fall of 7½ feet here and backwater for 1 mile. There is said to be 14 horsepower available with one Smith-Morgan turbine 20 inches in diameter. At lowest stages the stream at this point falls about 4 inches below the surface elevation at the time of measurement, and at such times it has about one-third less flow. During high-water periods the rise is about 6 feet. The highest water known was about 12 feet above the surface elevation at the time of measurement.

Steel Creek.—This tributary of Upper Creek, which rises on Hawks Bill and neighboring mountains, enters the latter creek near Joy. Its drainage area has the same general characteristics as that of the upper part of Upper Creek, and its fall will average 530 feet per mile for the first 3 miles, 200 feet per mile for the next 2 miles, and 50 feet per mile the rest of the way.

JOHN RIVER.

John River, the largest tributary of the Catawba, adds its water to the latter stream about 3 miles northeast of Morganton. Its drainage area contains 213 square miles and is extremely rough and mountainous in its upper part, the topography becoming gradually more gentle as the river is descended. It receives its headwaters from the many

fine, large springs and the run-off on Grandfather Mountain and the other mountains in the region near Blowing Rock.

This drainage basin, with its fine views, its dense forests, its numerous springs, and its salubrious climate, is one of the most beautiful and delightful parts of the Southern Appalachian region. The many summer guests at the hotels at Blowing Rock and Linville are well repaid for their visit by a day spent on the summit of Grandfather Mountain, from which is obtained a most magnificent view of the great billowy sea of mountains stretching away from it in every direction. A ride over the Yonahlossee road, the finest mountain road in the South, with its frequent glimpses of river valleys and mountain peaks beyond, with its numerous little streams which dash down the mountain sides, cross the road, and leap from rock to rock in their descent to join John River or one of their tributaries far below, is a pleasure to be long remembered.

The main stream and its upper tributaries, chief among which are Mulberry and Wilson creeks, have falls of 2,000 or 3,000 feet in the first few miles of their courses. Vertical falls are frequent, especially on Wilson Creek, and considerable power could be developed. Above Collettsville, at the junction of Mulberry Creek with John River, the drainage area is rough, the valley narrow, and the mountain slopes steep and well timbered. Below the junction the valley widens considerably, and where cleared of trees it presents a splendid farming country. There are great tracts, however, which are still in timber. On the ridge to the west of the river there has been considerable prospecting for gold, and a plan has been considered of constructing a flume to carry water from Wilson Creek across John River for use in hydraulic mining.

LOWER CREEK.

Lower Creek, the next tributary of the Catawba from the north, has a comparatively flat watershed. The fall is not so great as that of the upper branches, and in every way the creek has more the nature of a stream of the Piedmont Plain.

YADKIN RIVER.

PHYSICAL FEATURES.

Yadkin River rises on the eastern slopes of the Blue Ridge, in Caldwell and Watauga counties, near Blowing Rock, N. C. Its course is almost south, until at Patterson it turns to the northeast. It was examined and gagings were made as far down as Ararat River, a large tributary from the north. In this portion of its course it flows through Caldwell and Wilkes counties and between Yadkin and Surry counties.

Beginning at Siloam, where the flood plain of the river is about three-fourths of a mile wide, the bottom land gradually widens as the head of the stream is approached, being in some places nearly 2 miles in width. The flood plain is subject to occasional overflows. Its soil is very deep and fertile, the result of washings from the mountain slopes above. The river basin between Patterson and Siloam varies in width from 5 to 25 miles. The divides which separate it from the basins of the New and the Catawba are high and steep, so that the tributary streams are not very long, but they have large falls. On the north the river is flanked by the Blue Ridge, whose highest peaks attain elevations of more than 4,000 feet. On the south, and lying closer to the stream, are the Brushy Mountains, a low ridge which in places attains an elevation of 2,000 feet.

The upper part of the valley of the Yadkin is very well wooded, and the forests, with the deep soil on the mountain sides, tend to make the flow of the stream more constant than might be expected in the absence of lakes or marshes to act as regulators. The highest flood of which there is any record extant was in 1878, when the river rose 23 feet. The floods are of short duration, generally subsiding in from thirty-six to forty-eight hours. It is said that twenty-five years ago high floods very rarely occurred, and their frequency now is accounted for by the clearing of the hills and the removal of obstructions from the river.[a] The lowlands are more frequently overflowed than formerly, and more damage is done to the crops. The annual rainfall in the upper valley varies from 44 to 50 inches.

Between Patterson and Wilkesboro the lowlands are in places a mile or more in width and are exceedingly fertile. This region is known as Happy Valley, and is considered to be among the finest agricultural sections of the State. The chief products are corn, wheat, tobacco, cotton, cane, and fruits. The corn and wheat raised are especially good. Pasture land in the immediate vicinity is poor, but along the slopes of the Blue Ridge grazing is better and considerable hay is produced. The climate is salubrious. The Wilkesboro division of the Southern Railway passes up the north banks of the Yadkin as far as the town of North Wilkesboro. The only two towns of any importance along this part of the stream are Elkin and Wilkesboro. Both are growing rapidly and give promise of continual development.

The well-defined river basin of the Yadkin is marked by an apparently unbroken valley floor lying at an average elevation of 1,200 feet. This floor, which rises by a gentle inclination from about 1,100 feet along the river to 1,400 feet at the bases of the bounding ranges, can be seen to best advantage when standing on the steeper slopes of the mountains, as, for instance, on the road from Lambsburg to Cold Spring, in the northern part of Surry County. As soon as one approaches the tributaries or the river itself, it is evident that the valley floor is not continuous, but that it has been deeply trenched by

[a] Ann. Rept. Chief of Engineers U. S. A., 1878, p. 628.

nearly all of the streams belonging to this portion of the Yadkin river system. The trench now occupied by the main river is from 300 feet to 400 feet below the general level of the valley, and varies in width from a half mile to a mile and a quarter. The width of the trench is clearly influenced by varying resistance in the rock series crossed by the stream; the depth, however, seems to increase uniformly downstream, without relation to rock resistance. The bottom of the main trench is covered with alluvial sands, gravels, loams, or clay to a depth of from 15 to 20 feet. Through the bottoms thus formed the river pursues a meandering course, being sunk about 10 feet below the general level of the valley floor at Siloam and not more than 5 feet below in the vicinity of Patterson's mill.

The trenches cut by the tributary streams are narrower than the main trench, have steeper bounding slopes, which are sometimes precipitous, and have narrower bottoms, which often extend far up the streams. Near their mouths the tributary valleys are very narrow, their channels steep, and usually a number of low cascades over resistant layers characterize the debouchments of the streams upon the broader bottoms of the river.

Along the steep slopes of the trench of the main stream, and overlooking the lower bottoms, are two sets of river terraces, which have been partially cut out of the deeply decayed gneissic rocks and partially built up of stratified gravels, sands, and clays. These two terraces are at elevations of 20 and 60 feet above the lower bottoms. In places traces of a third terrace, at about 100 feet, can be seen. Deposits similar in character and form can be found in the tributary gorges, usually at the 100-foot elevation.

SOILS.

In general the rocks of the region are schists of moderate compactness, with gneissic and slaty bands in the vicinity of Blowing Rock. Near Mount Airy the metamorphic crystallines seem to have been cut by compact granitic rocks, which withstand weathering much better than the surrounding formation, and thus have formed low hills standing above the general level (1,200 feet) of the valley floor. The granitic rocks on disintegrating produce clays and sands; but the areas covered by the resulting soils are small. The metamorphic rocks generally produce clayey subsoils, with a not very porous top soil. In some localities an unusual amount of quartz in the rocks has resulted in the production of sandy soils. Thus the soils of the valley floor are generally rather heavy, with an impervious subsoil. Consequently neither heavy rains nor the average moderate precipitation penetrates to a great depth. Instead the water gathers into surface rills and rapidly finds its way into the streams, at the same time carrying with it a large portion of the looser surface soil.

The nearly level elevated valley floor has been almost wholly cleared of timber. In it areas of remarkable fertility occur at inter-

vals. These have been extended in size and in depth by the wash from the mountain sides. The soil of the slopes on the north side of the stream is largely siliceous and is well mixed with humus and vegetable mold, affording rich pasture and farm lands. The soil of the mountain slopes on the south side of the river is shallow and comparatively poor.

FORESTS.

The forest growth consists chiefly of oak, chestnut, poplar, and linn, with some pine, and with occasional patches of hemlock. Near the railroad considerable cutting of the best trees has been done, but in many parts of the area the timber is practically untouched. Considerable damage has also been caused by forest fires, though in most places the injury from this cause has not been serious or permanent.

DISCHARGE MEASUREMENTS.

During the investigation the following measurements were made of the river at various localities along its course:

Discharge measurements of Yadkin River.

Date.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.			*Feet.*	*Sec.-feet.*
June 20	Second ford below Patterson's mill	N. C. Curtis and Cleveland Abbe, jr.	13.30	182.0
July 14	do	do	13.50	100.3
Aug. 7	do	do	13.40	76.2
Sept. 26	do	do	13.53	43.0
June 21	Wilkesboro	do	26.73	780.0
June 23	do	do	26.14	1,737.0
July 4	do	do	26.83	663.0
July 12	do	do	27.05	488.2
Aug. 6	do	do	27.20	386.0
Oct. 1	do	do	27.20	369.1
Nov. 4	do	do	26.22	1,331.0
1901.				
June 8	do	do	25.81	1,762.0
June 14	do	do	16.50	11,667.0
June 15	do	do	14.22	12,582.0
June 18	do	do	23.80	3,727.0
1900.				
July 11	Siloam	do	2.90	1,367.0
Aug. 3	do	do	2.60	1,218.0
Oct. 31	do	do	3.10	1,469.0

NOTE.—At regular stations of the Geological Survey gages are installed by which the rise of the river is measured, an increase in the gage height representing an increase in the discharge of the stream. This is true of the measurements in the above table at Siloam. In making all of the other measurements, however, in each case a bench mark was established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. In these cases, therefore, an increase in the gage height means a lowering of the water surface and a corresponding decrease in the discharge of the stream.

For several years the Survey has maintained a gaging station on Yadkin River at Salisbury, also one at Norwood, both farther downstream than the present investigation extended, the results of which have been published in the annual reports. The station at Norwood was discontinued in January, 1900.

WATER POWERS.

Between Patterson's mill and the town of Patterson, about 4 miles farther upstream, Yadkin River is a meandering stream, with slight fall, occupying a wide, terraced trench about 80 feet below the general level of the trenched valley floor already described. Although there are many shoals with gravelly bottoms between Patterson and the mouth of Little Ararat River, there are no good water powers, because of the broad, alluvium-lined valley, which offers no anchorage for dams; nor are there any sharp falls or even important rapids sufficiently high to furnish useful power. About 1 mile above Brown's ford, 4 miles west of Wilkesboro, what seem to be gravelly shoals in the river accompany a fall in the channel of 5 feet within a quarter of a mile. The bottom lands on the north bank of the river at this place are only 200 feet wide. On the south side, however, they are somewhat wider and seem to afford poorer holding ground. Again, about 3 miles above Ronda the river runs at the bottom of a narrow, rock-ribbed trench, and its channel is cut across by rough ledges of hornblende-schist. This locality, with a channel fall of 5 or 6 feet, seems to be the best on the whole stretch of the main stream, having a good foundation for a dam and natural abutments.

There are no mills on the main stream between Patterson's mill and Siloam. At Patterson, 4 miles upstream from the mill mentioned, there are two mills. The first one, a cotton mill, has a fall of about 10 feet. The other one, a few hundred yards upstream, is a woolen factory operated during the greater part of the year by water power, but having an auxiliary steam plant for use during unusually low water. This mill uses a fall of 25 feet, obtained by sluicing the water 200 yards from a 15-foot dam.

Above Patterson the river occupies a narrow, rock-walled gorge, affording many good powers, though a number are at present inaccessible. About 1 mile above the woolen mill and sawmill just mentioned the whole volume of the river crosses Ripshin Mountain through a narrow water gap floored and flanked to a great height by firm gneiss and schist. The channel at this point has a drop of certainly 5 feet within half as many rods, and a dam 100 feet long and 10 feet wide would completely flood broad meadow lands to a distance of a mile upstream. About $1\frac{1}{8}$ miles upstream from this gap through Ripshin Mountain a small mill has been built to utilize a fall of 10 feet, and on Mill Fork, one-fourth mile above its confluence with the Yadkin, another mill, with an 8-foot fall, has been established, while about 1 mile above Kirby Gap this same stream (Mill Fork) has an almost perpendicular fall which is estimated to be 250 feet.

The following table contains interesting data regarding the elevation, fall, etc., of the river in various portions of its course above the mouth of Ararat River:

Elevation, fall, etc., of Yadkin River above Ararat River.

Place.	Distance from Siloam.	Elevation.	Distance between points.	Fall between points.	Fall per mile.	Average annual fluctuation.
	Miles.	*Feet.*	*Miles.*	*Feet.*	*Feet.*	*Feet.*
Mouth of Ararat River		798	50	130	2.6	6
Wilkesboro	50	928	32	322	10.06	7
Patterson	82	1,250	13	2,250	173.07	5
Head of stream	95	3,500				

Above its junction with Mill Creek the river pursues a winding course, flowing at the bottom of a very deep and narrow gorge, with an average fall of about 50 feet to the mile.

Below Ararat River the valley of the Yadkin averages 50 miles in width, much of it composed of fertile bottom lands. At several places, however, the hills close in upon the river, confining it between steep and rocky banks. In this lower portion of its course there are many places where water power could economically be developed. The following table gives the locations of the principal powers:

Summary of water powers on Yadkin River.[a]

Locality.	Distance from State line.	Drainage area.	Total fall.		Gross horsepower available.			Remarks.
			Height.	Length of shoal.	Minimum.	Minimum average for the low season.	Average for the low season of average dry years.	
	Miles.	*Sq. mi.*	*Feet.*	*Feet.*				
Bluitts Falls	12.0	6,650	9.00	1,000	1,500	1,900	2,170	
Grassy Island Shoal	13.0	6,624	36.00	[b]4.5	5,970	7,600	8,680	
Swift Island Shoal	42.0	4,323	18.00	[b]2.5	1,942	2,476	2,796	
Gunsmith Shoal	57.5	4,300	9.50	2,500	1,020	1,300	1,470	
Narrows	60.0	3,938	91.00	[b]5	8,954	11,375	12,922	
Bull Island Shoal	65.0	3,800	29.00	[b]2	2,854	3,625	4,118	Undeveloped.
Penningtons Shoal	67.0	3,900	74.00	[b]4.5				
Milledgeville Shoal	70.0	3,500	14.00	[b]0.7	1,378	1,750	1,988	
Motts Falls	72.3	3,400	13.50	[b]0.8				Do.
Bald Mountain Shoal	73.8	3,300	8.50	[b]0.5				Do.
Flat Swamp Mountain Shoal.	78.3	3,000	10.20	[b]6.5				Do.
Fries Manufacturing and Power Co.	131.5	1,865	10.00	1,600				Rock bottom.
Langenhour & Neason's dam.	138.5	1,827	4.57		220	280	325	Do.
Shallow Ford Shoal	145.0	1,812	7.89	5,560	375	485	550	Rock and gravel bottom.
Shoal above Shores Island.	155.2	1,633	7.73	9,662	330	430	490	Do.
Bean Shoal (head)	164.7	1,521	39.17	[b]4	1,560	2,030	2,320	Rock bottom.
Lime Rock Shoal	169.3	1,165	10.62	[b]2.59	325	425	490	Do.
Shoal below Rockford	174.8	1,097	8.38	4,500	240	320	360	Do.
Seven Island Shoal	177.0	1,066	4.02	2,630	112	145	165	Do.
Long Shoal	182.0	949	11.18	[b]1.61	205	335	385	Do.
Woodruff Fishtrap Shoal.	185.0	925	4.55	1,800	105	134	155	Do.
Mitchell Island Shoal	186.6	925	4.00	2,740	90	115	135	Gravel bottom.
Swan Creek Shoal	196.7	739	5.40	3,160	100	125	145	Rock bottom.
Reeve Island Shoal	206.5	540	3.86	2,700	50	65	75	Rock and gravel bottom.
Blair Island Shoal	216.5	420	3.44	1,700	36	46	53	Gravel bottom.

[a] From Bull. No. 8, N. C. Geol. Survey.

[b] Miles.

It will be seen that the fall is not in the form of direct vertical drops, but in shoals of considerable length. One of the greatest drawbacks to the development of power in a large part of the Yadkin is the lack of proper means of transportation.

TRIBUTARIES OF YADKIN RIVER.

DISCHARGE MEASUREMENTS.

The following measurements were made of the important tributaries of the Yadkin to and including Ararat River, in order downstream:

Discharge measurements of upper tributaries of Yadkin River.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1900.				*Feet.*	*Sec.-ft.*
June 20	Elk Creek	One-fourth mile above ford	Cleveland Abbe, jr., and N. C. Curtis.	2.4	119.0
July 13	do	do	do	2.43	61.0
Aug. 6	do	do	do	2.60	37.0
Sept. 26	do	do	do	2.61	30.0
June 21	Stony Creek	Footbridge at Colberts	do	2.65	78.4
July 13	do	do	do	2.70	80.5
Aug. 6	do	do	do	.....	50.0
Sept. 26	do	do	do	2.87	31.10
June 21	Louis Fork of Yadkin River.	Footbridge on Mount Pleasant road.	do	3.10	127.0
July 13	do	do	do	3.23	99.0
Aug. 6	do	do	do	3.30	69.0
Sept. 26	do	do	do	3.33	63.0
June 23	Reddie River	North Wilkesboro	do	24.73	218.1
July 12	do	do	do	25.15	98.1
Aug. 4	do	do	do	.....	93.0
Oct. 1	do	do	do	25.25	60.2
June 23	Mulberry River	Trestle of Greensboro and Wilkesboro division of Southern R. R.	do	21.93	108.4
July 3	do	do	do	22.25	50.3
Aug. 4	do	do	do	22.50	39.25
Sept. 27	do	do	do	22.42	61.2
Nov. 2	do	do	do	.....	55.0
June 25	Roaring River	Greensboro and Wilkesboro R. R. bridge.	do	23.68	520.2
July 9	do	do	do	25.45	161.4
Aug. 4	do	do	do	25.75	117.0
Sept. 27	do	do	do	25.13	109.0
Nov. 2	do	do	do	24.27	197.0
Sept. 27	Big Bugaboo Creek	Ford of road from Roaring River to Elkin.	do	1.28	30.0
June 25	Big Elkin River	Greensboro and Wilkesboro R. R. bridge.	do	24.53	65.0
July 9	do	do	do	25.95	29.0
Aug. 4	do	do	do	.....	24.0
Sept. 27	do	do	do	26.22	27.0
June 26	Mitchell River	do	do	21.63	393.1
July 10	do	do	do	24.00	139.2
Aug. 3	do	do	do	24.25	119.0
Sept. 28	do	do	do	24.25	160.0
Nov. 1	do	do	do	23.89	216.0
June 26	Fisher River	Greensboro and Wilkesboro R. R. trestle.	do	20.93	549.0
July 10	do	do	do	23.38	172.0
Aug. 3	do	do	do	23.60	126.0
Sept. 28	do	do	do	23.72	119.0
Nov. 1	do	do	do	23.70	235.0
June 27	Ararat River	do	do	23.9	801.0
July 11	do	do	do	26.0	317.1
Aug. 2	do	do	do	26.25	265.44
Sept. 29	do	do	do	26.46	243.0
Oct. 31	do	do	do	25.66	307.0

NOTE.—In making the measurements recorded in the above table bench marks were established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. An increase in the gage height, therefore, means a lowering of the water surface and a corresponding decrease in the discharge of the stream, the reverse of the results at the regular stations of the Survey, where gages are installed and where an increase in the gage height represents an increase in the discharge of the stream.

The drainage basins and water powers of the principal tributary streams are briefly described on the following pages. Practically all of the tributaries whose water powers are worth considering flow into the Yadkin from the north. The divides and spurs, between which are the basins of the tributary streams, are seldom more than a mile wide and form many picturesque coves and valleys.

ELK CREEK.

This stream was measured at a foot log about one-fourth of a mile above the road ford at Elkville. At the point of measurement and for a short distance above and below are cascades over broad ledges of gneiss, and the stream is bounded by steep, rocky slopes. The natural fall is estimated to be at least 10 feet within 200 yards. Higher up the stream there are undoubtedly other fair powers, but they were not examined.

STONY CREEK.

This stream enters the Yadkin from the north about 6 miles below Elkville, and possesses a splendid power at its mouth and for a short distance upstream. Throughout the last half mile of its course the banks are the steep, rocky sides of a narrow, V-shaped gorge. Within this distance the stream has an estimated fall of at least 50 feet, flowing over a series of ledges in falls or cascades of from 6 to 10 feet each. Just at the mouth of the creek there stands a combined sawmill and gristmill driven by turbine power. The dam is only 6 feet high, but is so favorably placed on ledges that about 18 feet head is obtained. This is an excellent mill site, but the road leading down to it from the surrounding country is poor and is on a steep grade. The stream was measured at a foot log about 3 miles above its mouth, where it flows through a sandy meadow or bottom one-fourth of a mile wide. So far as examined this stream offers a number of good mill sites, for its valley is everywhere bounded by steep mountain sides, and in many places is narrow, by reason of the occurrence of bands of resistant gneiss and schist.

LOUIS FORK.

This stream has a large drainage basin, served by its two branches, East Fork and West (or South) Fork. The valleys of these branches are generally open and are largely cleared, the bottom lands, of which there is a large area, being under cultivation. The discharge was measured (see table on page 164) at a foot log where the Mount Pleasant road crosses the stream, just below the confluence of the East and West forks. The bottom at this place is rather sandy and gravelly, with some large bowlders. About one-fourth of a mile downstream, however, the creek leaves the meadows and enters a narrow,

steep-sided gorge containing many rocky ledges. There are one or two small gristmills on the forks above the point of measurement, which is nearly 3 miles from the mouth, but so far as known there are none below it.

UNNAMED TRIBUTARY EAST OF LOUIS FORK.

There is a small stream which heads in the mountains northeast of Purlear and enters the Yadkin from the north about a mile west of Brown's ford, on which there is considerable fall, over rock ledges, at the mouth. This fall is utilized by a gristmill and yields a head of 10 feet, although the dam is only 5 feet high. The stream is so small that it was not possible to measure its discharge satisfactorily with the large meter. Judging from the wooded character of its valley, however, it has a fairly uniform flow throughout the year, and its steep grade gives much more power than is now used.

REDDIE RIVER.

This river heads far up among spurs of the Blue Ridge, between Horse Gap on the west and Mulberry Gap on the east. Its headwaters are moderately well wooded, but along its middle course there is more open and cleared valley land. There are several mills on the stream, the more important ones being a gristmill at Whittington and two mills at its mouth, just above North Wilkesboro. The latter mill site is an admirable one, the shoal being 10 or 15 rods wide, rock-floored, and excellent rock abutments being furnished by the ledges on either bank. The natural fall in the channel is about 10 feet, half of which is utilized, by means of a 9-foot dam, by a gristmill and flour mill on the west bank. One hundred yards below the dam a sash factory uses a fall of about 14 feet, obtained by sluicing the water from the dam to the east bank of the stream.

The river is reported to be not subject to rapid fluctuation, thus distinguishing it from most of the other streams of the neighborhood.

MULBERRY RIVER.

This river also rises far back in the Blue Ridge, starting near Mulberry Gap and flowing southeastward. Its valley, which is rather broad, is covered with alluvium and offers relatively few mill sites. The average grade of the channel seems to be much less than that of most of the streams of the district. In the upper stretches falls and rapids are more numerous than in the lower portions of its course. About halfway between Mulberry and Halls Mills there is a shoal which affords fall for Wood's gristmill and sawmill, giving the wheel 8 feet head. So far as known this is the only mill on the stream. At the crossing of the road between North Wilkesboro and the town of Roaring River there is an excellent little fall of about 6 feet, due to

a broad ledge of rock which crosses the stream and furnishes a good abutment on the west bank. At the Southern Railway trestle there is also a series of cascades furnishing 6 feet fall, with good abutments on the east bank. The river was measured at the trestle, which is about halfway between the Yadkin and the steep hillside forming the northern boundary of that river's flood plain.

ROARING RIVER.

This stream is much larger than Mulberry River and possesses many good water powers. Those at present best known are the one about 4 miles below Dockery, which is near the junction of the eastern and western forks, and the one at the mouth of the stream.

Just above the confluence of the two chief forks a small stream enters the western fork from the southwest. Where the road from Round Mountain to Dockery crosses it the average fall is 100 feet per mile. Here Spencer Blackburn has built a small mill which uses a fall of 20 feet. Passing on to the two forks and to the main stream below the ford of the eastern road from Round Mountain to Dockery, the river is very rapid and is confined between high and steep banks. Its fall averages 20 feet to the mile, and the shoals, including the Big Shoals, cover a distance of about 1 mile. All of this fall can be made to furnish excellent power, both on the main stream and on the northern fork, which joins the river at this point, after draining a region to the northeast lying between Hank Store and Lomax.

Though narrow and steep sided in the vicinity of the Big Shoals, the valley widens a short distance below, and the stream possesses no valuable powers until about one-fourth mile above the railway trestle at its mouth, where a series of cascades over firm rock ledges causes the channel to drop 15 feet within half as many rods. At the trestle the valley opens out into the sandy flood plain of the Yadkin.

BIG ELKIN RIVER.

This stream has three noteworthy falls, which give it an important place among the water powers of the upper Yadkin Valley. The most important falls, or series of falls, so far as water power is concerned, are Carters Falls, about 3 miles above the mouth of the stream, at a place known as Cool Spring Church. When visited during the summer of 1900 these falls had a comparatively small volume of water. They are occasioned by a broad band of resistant hornblende-gneiss. The upper fall, which is the greater, was measured by a hand level and found to be 60 feet in a distance of 100 yards. From the foot of this fall the stream runs over low ledges for an eighth of a mile to a lower fall which is about 15 feet high. The latter fall is utilized by a small turbine-driven gristmill on one bank and by a small lumber mill on the other bank. The owner of

the land states that he has measured the total fall here, from the head of the upper to the foot of the lower falls, by means of accurate instruments, and finds it to be 92 feet, which seems quite possible. The banks of the gorge are steep and of firm rock, affording the finest water-power site between Ararat River and the source of the Yadkin.

About a half mile below the lower falls mentioned there is a fall of about 25 feet, part of which has been utilized by Butler's gristmill, which has a dam 6 feet high yielding 14 feet head. By extending the race a few yards farther downstream a head of 20 feet could be obtained. During high water there is a maximum rise of 3 feet above the top of the dam.

The other powers are near the mouth of the river, in the towns of Elkin and Elkin Valley. At the former place, where there is a favorable rock bottom and decided falls, are two dams; at the latter place, which is higher upstream, there is a gristmill and flour mill with a 10-foot dam and a fall of 18 feet.

MITCHELL RIVER.

This stream was measured just below a series of low rapids over rocky ledges, marking the point of transition from the rocky channel of back country to the sandy flood plain of the Yadkin. The fall, about 10 feet, has not been utilized though it is favorably situated. About 1 mile upstream Burch's flour mill obtains power from a tributary—Snow Creek. At Guyer Ford, 6 miles above the mouth, there is a broad shoal which would give 5 to 7 feet fall within a quarter of a mile.

The valley of Mitchell River is similar to that of Fisher River, being rather narrow, with steep side slopes, but it has been somewhat more cleared than the latter valley. Perhaps half the area of the immediate slopes is now bare of trees, while in the valley of Fisher River two-thirds of the timber seems to be standing.

FISHER RIVER.

This stream was ascended only a short distance. No improved mill sites were found, though a number of small mills are reported along its upper course. Many mills, however, are located on small tributaries of the river. The stream is a large one, being 30 to 40 miles long, rising far back upon the Blue Ridge, in about the same latitude as Mount Airy. Probably the only good mill site is at the neck of what is known locally as The Oxbow or The Horseshoe, a semicircular bend in the river about 5 miles southeast of Dobson. The two arms of this loop come within 100 yards of each other at the narrow neck, and there is said to be a difference of 20 feet in the surface level of the river on the two sides. It has been suggested that this difference in level be utilized by piercing the neck with a tun-

neled race, but nothing in that direction has yet been done. At the ford of the road between Snow's mill and Butcher there are shoals due to a fall of perhaps 5 feet in one-fourth of a mile, and at the ford southwest of Butcher there is a long shoal giving 4 or 5 feet fall in 200 yards. The valley appears too wide for dam construction, but just below the second shoal mentioned it narrows and closes in for a short distance.

ARARAT RIVER.

Ararat River is the largest of the upper tributaries of the Yadkin. It rises on the Blue Ridge, about 10 miles north of Mount Airy, at an elevation of 2,500 feet, and flows almost due south for 30 miles, emptying into the Yadkin 1 mile below Siloam. The average fall per mile from the mouth to Mount Airy, a distance of 20 miles, is 14.6 feet. Above Mount Airy, where the fall is much greater, there are a number of small gristmills.

NEW RIVER.

New River rises in Watauga County, N. C., and flows in a general northeasterly direction through Watauga and Ashe counties. It then follows the North Carolina–Virginia State line for about 12 miles, when it turns to the north and joins Kanawha River, its waters finally reaching the Ohio. Just before it intersects the North Carolina-Virginia boundary line there is a confluence of two branches of almost equal size, known as the South Fork and the North Fork. The North Fork drains the eastern slopes of the Iron Mountains along the southwestern border of Ashe County, N. C. Both forks are formed by the junction of several branches which drain the mountain slopes. The total drainage area of the two forks is 631 square miles.

Examination of the drainage basin of the river was made as far down as Oldtown, in Grayson County, Va., about 7 miles below the confluence of the North and South forks. The upper part of the basin is rough and mountainous, the stream flowing through gorges and narrow valleys with rocky slopes and bottoms. The occasional widening of the valleys, however, furnishes favorable sites for dams and mills. The soil is for the most part deep and fertile, making a fine agricultural region. According to the census of 1880, 92,000 acres were under cultivation, 57,000 acres were in grass, and 240,000 acres, or 61 per cent of the whole, were in original timber. The annual rainfall in the basin, as indicated by a single station, viz, Blowing Rock, is about 49 inches, distributed as follows: Spring, 11.3 inches; summer, 16.2 inches; autumn, 9.7 inches; and winter, 11.8 inches. The region is rich in mineral resources, especially in iron and copper, though very little has been done in the way of development.

The total length of the river between the junction of the forks and Oldtown, Va., is about 35 miles, and the average fall per mile about

8.5 feet. The river winds its way in narrow gorges formed by the shutting in of the hills on either bank. Bottom land is therefore scarce. The section of Virginia through which this portion of the river flows is chiefly devoted to stock raising. The land is fertile and the soil deep and of a reddish color. The region is well settled, the people thrifty, and large and well-cultivated farms can be seen everywhere. Wheat and other grains are the chief crops.

During the investigation a gaging station was established (July 31, 1900) near Oldtown, Va., and two measurements were made there (see table below). Measurements were also made of tributaries of the river between the confluence of the North and South forks and Oldtown, as shown in the following table. The basins of the North and South forks are described under separate headings, and the measurements made on those streams and their tributaries are given in the tables on pages 172 and 174.

Discharge measurements of New River near Oldtown, Va., and of its tributaries between confluence of North and South forks and Oldtown.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge
				Feet.	*Sec.-ft.*
1900. July 28	Wilson Creek	2 miles above mouth	Cleveland Abbe, jr., and N. C. Curtis.	6.3	35.1
Oct. 28	do	do	do	6.1	78.0
July 29	Fox Creek	One-fourth mile above mouth	do		85.0
Oct. 28	do	do	do		144.0
1901. June 28	do	do	do		352.0
1900. July 31	Peach Bottom Creek	200 yards above mouth	do	4.9	21.4
Oct. 29	do	do	do		36.0
July 31	Little River	Ford of Independence-Oldtown road.	do	9.1	199.0
Oct. 29	do	do	do		318.2
July 30	Elk Creek	200 yards above mouth	do	4.0	57.1
July 31	New River	Near Oldtown	do	6.6	1,541.0
Oct. 29	do	do	do	6.3	2,293.0

NOTE.—In making the measurements recorded in the above table bench marks were established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. An increase in the gage height, therefore, means a lowering of the water surface and a corresponding decrease in the discharge of the stream, the reverse of the results at the regular stations of the Survey, where gages are installed and where an increase in the gage height represents an increase in the discharge of the stream.

The water powers of all of the streams mentioned in the foregoing table are excellent, and many of them have already been developed. At the mouth of Wilson Creek there are two mills—the lower one a grain mill with a fall of 12 feet, and the upper one a woolen factory, owned by Fields & Hash. On Peach Bottom Creek, 2 miles east of Independence, is the gristmill of D. C. Mallory. The total fall here is about 65 feet.

SOUTH FORK OF NEW RIVER.

GENERAL FEATURES.

This stream is formed by the confluence of the East Fork, the Middle Fork, and Flannery Fork, near Deckhill, Watauga County, N. C. The Middle Fork, which is the largest of the three tributaries mentioned, rises just north of Blowing Rock, at the boundary line between Watauga and Caldwell counties, at an elevation of between 3,700 and 3,800 feet. The elevation at the junction of the North and South forks being 2,500 feet, the difference in elevation between the head and the mouth of the South Fork is 1,300 feet, the distance 45 miles. This gives an average fall of 29 feet to the mile. As the course of the stream, however, is extremely crooked the slope is hardly 20 feet to the mile. Shoals and available water powers are not numerous on the main stream, but on the branch streams they are more frequent and have been more extensively utilized.

The area drained by the South Fork presents a very great diversity of scenic features. The general course of the stream is parallel to the Blue Ridge. On the north are very high knobs and ridges. The highest of these is Snake Mountain, 5,594 feet high. The scenery presented though not rugged is extremely beautiful. The basin of the river is for the most part closed, and there are no extensive bottom lands.

The proportion of unimproved cleared land in Watauga and Ashe counties is small compared with the agricultural lands. On many of the mountains the timber is practically untouched. The trees, however, are not of the most valuable varieties. They are chiefly maples and chestnuts. The larger portions of the cleared land are devoted to the production of grass and hay, and consequently the raising of cattle and sheep is a most important industry. The chief crops are corn, wheat, buckwheat, and cabbages, to all of which the soil is especially well adapted. Large quantities of apples are also produced. The people are well to do and prosperous. The region is very healthful; typhoid and malarial fevers are unknown.

No railroad has yet penetrated Watauga County, though a route has recently been surveyed and a tax voted. The route surveyed crosses the Blue Ridge at Cook Gap. The country roads are for the most part good and are being improved and kept open for travel. The turnpike between Boone and Blowing Rock is remarkably well graded, and it is possible for loaded wagons to cross the Blue Ridge to Lenoir throughout the year. Lenoir is at present the shipping point for the produce of the county. The people of Ashe County are not so progressive in the matter of road building as are the people of Watauga County.

Both the North Fork and the South Fork are at times swollen by heavy freshets, which are often very destructive to crops on the bottom lands. Occasionally the soil is entirely removed from the bottoms and the bed rock exposed. More often, however, where the current is not very swift, a rich coating of black mud from one-half inch to 4 inches thick is deposited, enriching the lowlands considerably.

DISCHARGE MEASUREMENTS IN BASIN.

During the investigation a gaging station was established on the South Fork at New River, N. C. The measurements made there, as well as those made at Riverside, also the measurements made on the tributaries, are given in the following table, in order downstream:

Discharge measurements of South Fork of New River and its tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
1900. July 28	South Fork of New River	New River	Cleveland Abbe, jr., and N. C. Curtis.	2.70	751.0
Oct. 28	do	do	do	2.60	1,635.0
1901. June 27	do	do	do	3.90	1,976.0
1900. July 18	do	Riverside	do	11.85	165.0
Oct. 25	do	do	do	11.00	741.1
1901. June 24	do	do	do		968.0
Do	do	Ford near mouth of Middle Fork of New River, near Boone.	do	7.10	159.0
Do	West Fork	Near Boone	do	5.40	108.0
1900. July 23	Flannery Fork	Ford of Boone-Blowing Rock road.	do	6.35	10.4
Oct. 24	do	do	do	5.35	107.0
July 23	Middle Fork	Ford of Boone-Aho road	do	5.70	24.4
Oct. 24	do	do	do		234.0
July 23	East Fork	do	do	5.70	10.4
Oct. 24	do	do	do	5.10	109.0
July 18	Meat Camp Creek	One-fourth mile below Moretz.	do	9.00	35.3
Oct. 25	do	do	do	8.65	89.0
1901. June 24	do	do	do	7.90	164.0
1900. July 24	Elk Creek	Elk Crossroads	do	8.00	10.0
July 18	Old Field Creek		do	6.1	19.4
July 24	Gap Creek	One-eighth mile above mouth	do	4.85	23.4
July 19	Beaver Creek	At mouth	do	6.00	22.4
July 27	Mulberry Creek	Near mouth	do	5.1	109.0
Do	Prather Creek	One and one-half miles below Scottville.	do	8.6	25.0

NOTE.—In making the measurements recorded in the above table bench marks were established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. An increase in the gage height, therefore, means a lowering of the water surface and a corresponding decrease in the discharge of the stream, the reverse of the results at the regular stations of the Survey, where gages are installed and where an increase in gage height represents an increase in the discharge of the stream.

WATER POWERS IN BASIN.

There are a number of undeveloped water powers on the South Fork and its tributaries, the chief of which are the following:

On the Middle Fork, about 5 miles from Blowing Rock, there is a fall of possibly 15 feet in 100 feet, with a good dam site, though the space for building purposes is somewhat cramped. On Meat Camp Creek, at Moretz, there is a mill with a dam about 8 feet high. On Elk Creek, at Elk Crossroads, there is a small sawmill. The discharge of this stream is slight, but a fall of about 20 feet has been obtained. On Beaver Creek, at the town of Beavercreek, is Hamilton's corn and flour mill, with a working head of about 10 feet.

Near the mouth of the South Fork are the remains of an old dam. The site is a good one, a rock ledge running entirely across the stream and high hills shutting in close on both banks. A dam 40 feet in height could easily be constructed here. Near Scottville the river makes an almost closed loop, and it has been proposed to tunnel through the neck of the loop and in that way develop a fall. It is said that the difference in the elevation of the surface of the water on the upper and lower sides of the loop is about 30 feet.

Owing to the steep slopes of the adjacent mountains the river and its tributaries are subject to floods, and dams and buildings for the development of the water powers would have to be built strong and substantial.

NORTH FORK OF NEW RIVER.

GENERAL FEATURES.

The North Fork is formed by the junction of Hoskin Fork and Brush Fork in the extreme southwestern part of Ashe County.

The character of the region through which it flows is more mountainous than the basin of the South Fork; the same general agricultural and forest conditions prevail here as in the latter basin. The stream is not so tortuous as the South Fork, but its side streams are more numerous and the fall greater. Its total length is about 30 miles. The difference in elevation between its head and the junction with the South Fork at Weaversford is 1,800 feet, making the average fall per mile 60 feet.

Its main upper branch, Hoskin Fork, rises on the eastern slope of Snake Mountain, at an elevation of 4,300 feet. It flows between closed hills, and its flood plain is very narrow.

The ratio of cleared to forest-covered land in the watershed is estimated to be about 1 to 5. The region about the headwaters is very thinly settled. The scenery is magnificent, especially near Creston and Solitude. The cleared land is chiefly devoted to cattle grazing.

DISCHARGE MEASUREMENTS IN BASIN.

On July 27, 1900, a gaging station was established on the North Fork at Weaversford, N. C. The measurements made there, as well as those made at other points along the river, also the measurements made on its tributaries, are given in the following table, in order downstream:

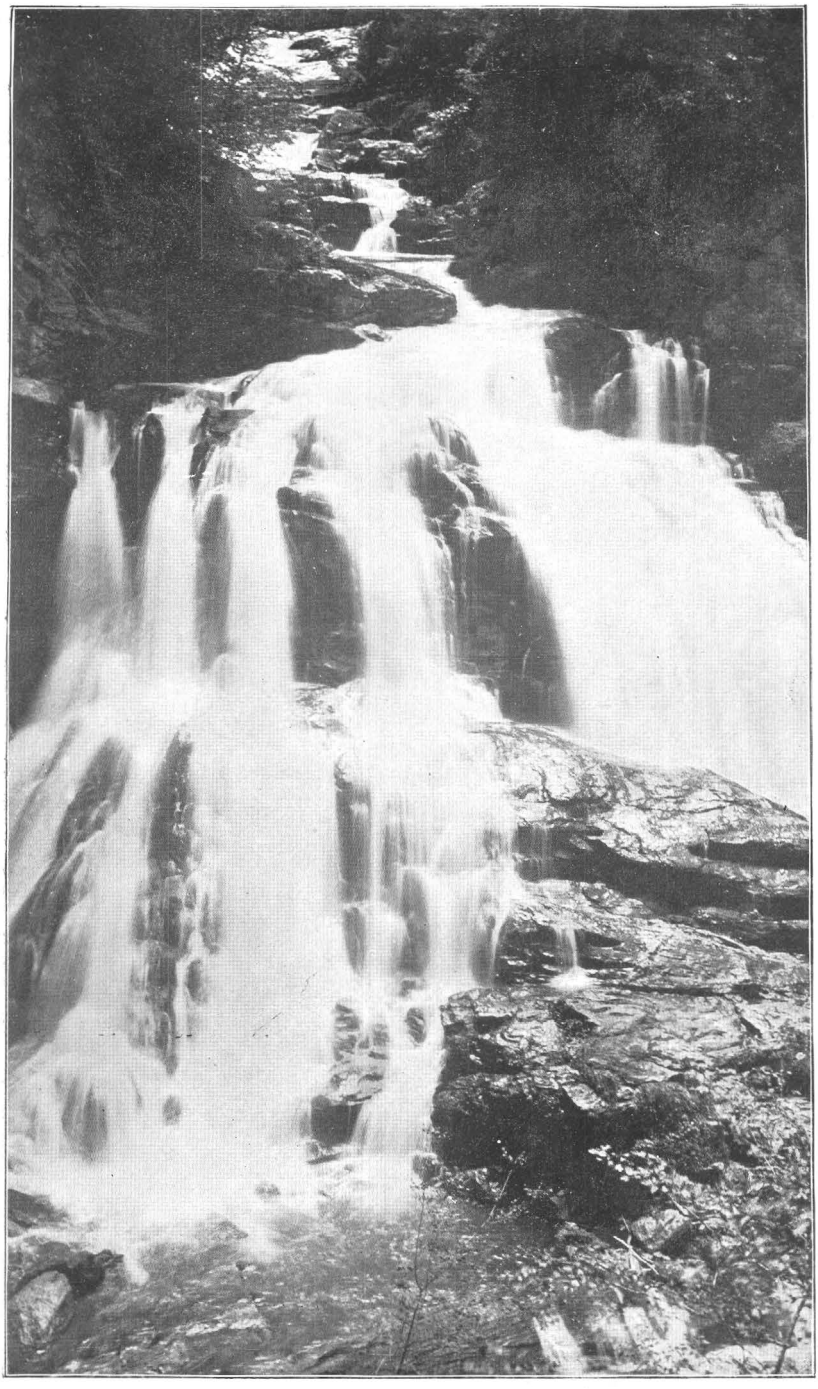
Discharge measurements of North Fork of New River and tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
1900. July 28	North Fork of New River.	Weaversford	Cleveland Abbe, jr., and N. C. Curtis.	0.60	536.0
Oct. 27	do	do	do	0.90	708.0
1901. June 27	do	do	do	1.40	1,377.0
June 20	do	Below mouth of Laurel Creek	do	1.00	313.0
1900. July 21	do	1 mile below Creston	do	6.7	49.3
Oct. 26	do	do	do	6.0	194.0
1901. June 20	do	do	do	5.5	196.0
1900. July 20	do	¼ mile from Creston, on road to Solitude.	do	2.65	32.2
Do	Threetop Creek	Creston	do	6.75	130.0
July 21	do	do	do	7.25	37.0
July 20	Big Laurel Creek	100 yards above mouth	do	6.40	26.2
Oct. 26	do	do	do	6.30	80.4
July 20	Buffalo Creek	⅛ mile above mouth	do	5.43	44.0
Oct. 26	do	do	do		67.0
1901. June 20	do	Near Jefferson	do	4.30	140.0
1900. July 25	Horse Creek	¼ mile above mouth	do	6.6	34.3
Oct. 27	do	do	do	6.05	140.0
1901. June 25	do	do	do	5.35	444.0
1900. July 25	Helton Creek	Below Peasley's mill	do	4.28	30.0
Oct. 27	do	do	do		105.0

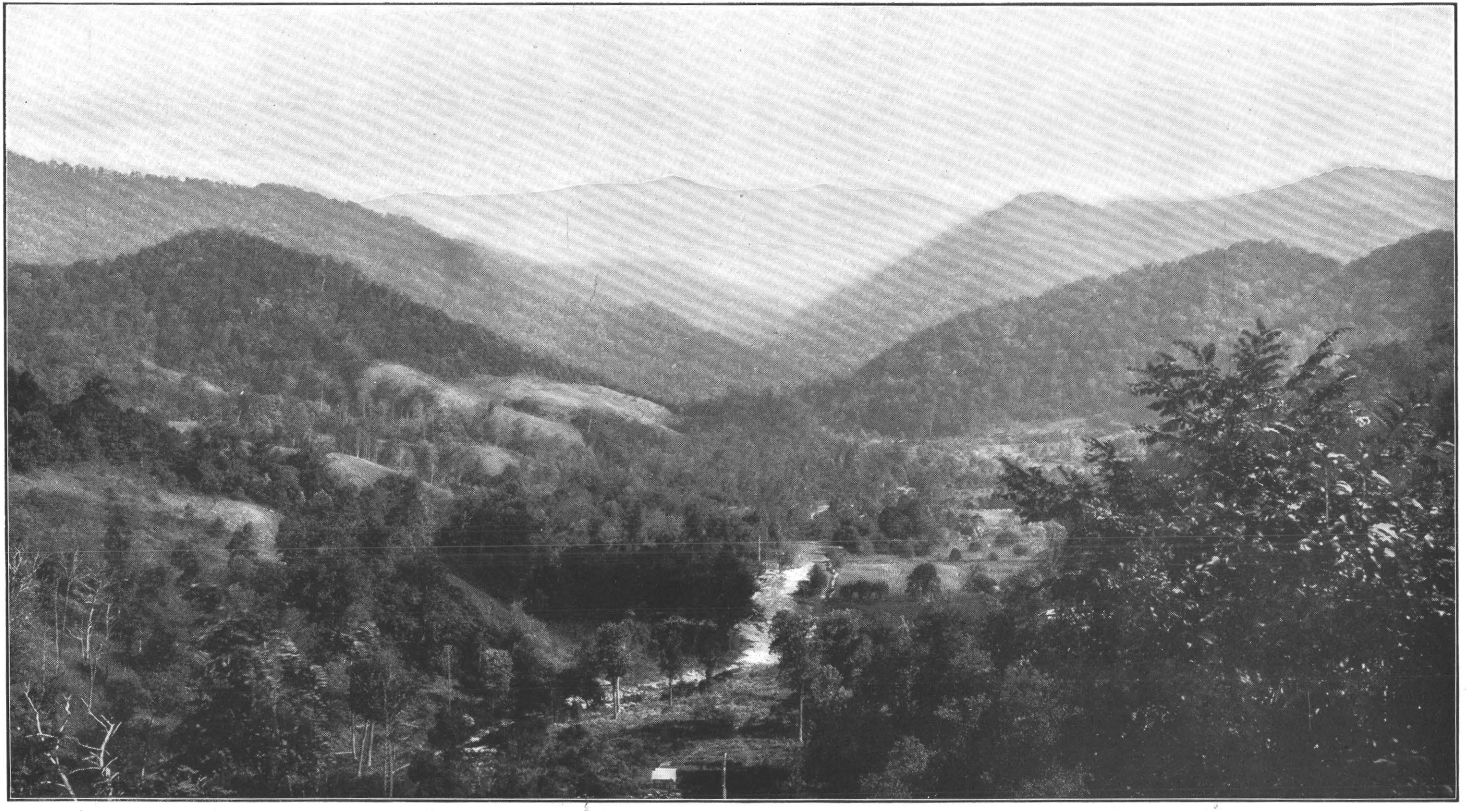
NOTE.—At regular stations of the Geological Survey gages are installed by which the rise of the river is measured, an increase in the gage height representing an increase in the discharge of the stream. This is true of the measurements in the above table made at Weaversford. In making all of the other measurements, however, in each case a bench mark was established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. In the latter cases, therefore, an increase in the gage height means a lowering of the water surface and a corresponding decrease in the discharge of the stream.

WATER POWERS IN BASIN.

There are a number of water powers in the basin. Those of Threetop Creek are very good. Four mills were observed, with falls ranging from 6 to 15 feet. Shoals and dam sites are numerous. At the falls of Long Hope Creek, a branch of Threetop Creek, there is a total fall of 300 feet in 400 yards. The average discharge of Long Hope Creek is about 10 second-feet. On the North Fork about 3 miles west of the mouth of Buffalo Creek, near Dresden, there is an important water power which at one time was utilized, but the dam was destroyed by a freshet and has not been rebuilt. The hillsides at this point shut



LOWER FALLS OF CULLASAGEE CREEK, NORTH CAROLINA, A TRIBUTARY OF LITTLE TENNESSEE RIVER.



OCONALUFTY VALLEY, NORTH CAROLINA.

in close, and a rock ledge extends across the stream. A fall of 30 or 40 feet could readily be obtained. Horse Creek and Helton Creek are both large streams with considerable fall. No water powers were observed on the former. A combined sawmill and gristmill is located about a half mile above the mouth of Helton Creek. The fall obtained is about 10 feet and the power is developed by turbines. This is also the site of the old Helton iron works, where hammered iron was formerly worked, the ore being obtained in the vicinity. On the North Fork about 2 miles from its mouth is Dixon's corn and flour mill. A dam about 8 feet in height has been constructed here. The flume leading to the forebay is a tunnel cut through a projecting shelf of rock, behind which is a mill house. A masonry dam 40 feet high could be constructed and the power greatly increased.

STREAMS SOUTHWEST OF FRENCH BROAD RIVER.

South and west of the region already described is a large, mountainous area with many of the same characteristics. From this territory flow the headwaters of four of the largest rivers in the Southeastern States. First comes the Tennessee River, the basins of several of the largest branches of which, namely, the Holston, the Watauga, the Nolichucky, and the French Broad, have been described in detail in this paper. Farther south are the Oconalufty, the Tuckasegee, the Nantahala, the Hiwassee, the Okoee, and other rivers which enter the Tennessee and after a long and winding course add their waters to the Mississippi. (Typical views of these streams are shown in Pls. XXXIX to XLIV.) The second large river is the Savannah, which receives numerous tributaries and flows in a southeasterly direction into the Atlantic. The third stream is the Apalachicola River, which with its chief tributary, the Chattahoochee, rises close to the headwaters of the Tennessee and after a southerly course between Georgia and Alabama and through Florida enters the Gulf of Mexico at Apalachicola. The fourth large stream is the Mobile, which receives its headwaters from the mountains of Tennessee and northern Georgia, through the Coosa, the Conasauga, and the Etowah, and flowing through the State of Alabama enters the Gulf at Mobile.

Hydrographic studies and numerous measurements of discharge, in charge of Prof. B. M. Hall, have been made by the United States Geological Survey of the headwaters of all of these streams and of their chief tributaries. Most of the streams rise on the steep slopes of the mountain sides, at elevations of from 2,000 to 4,000 feet above sea level, and have large falls throughout their courses. In many places the streams flow through mountain gorges with steep, vertical sides and with very small flood plains.

Only a small proportion of the region is under cultivation, the greater part being still covered with the original forest growth, consisting of oak, hickory, chestnut, poplar, locust, pine, buckeye, linn, ash, maple, sassafras, walnut, and other varieties. The ground is

frequently covered with trailing arbutus, maidenhair and other ferns, deep-green mosses, and a great variety of wild flowers and rare medicinal plants. The climate is mild throughout the year, making it a fine resort in winter as well as in summer. Wild animals, such as deer, bears, and wolves, once so numerous, are now nearly extinct, but there are still many wild-cats, catamounts, minks, foxes, opossums, ground hogs, polecats, weasels, wild turkeys, pheasants, squirrels, rabbits, quails, etc. The land now under cultivation is practically all that is available for ordinary farming, the remainder being steep, rocky, and rugged, with only occasional patches of deep, fertile soil. Near the rivers considerable timber has been cut, but the lumbering has not extended far up the mountain sides. Means of transportation are exceedingly meager, the Murphy branch of the Atlanta, Knoxville and Northern Railway being about the only outlet. For this reason the few farming products that are raised can not be transported economically to the populated districts, so that there is little incentive to agricultural pursuits. The greater portion of the grain raised is made into moonshine whisky, and the summer apples are largely used for apple-jack. Wheat, cabbages, Irish potatoes, and the hardier fruits grow well.

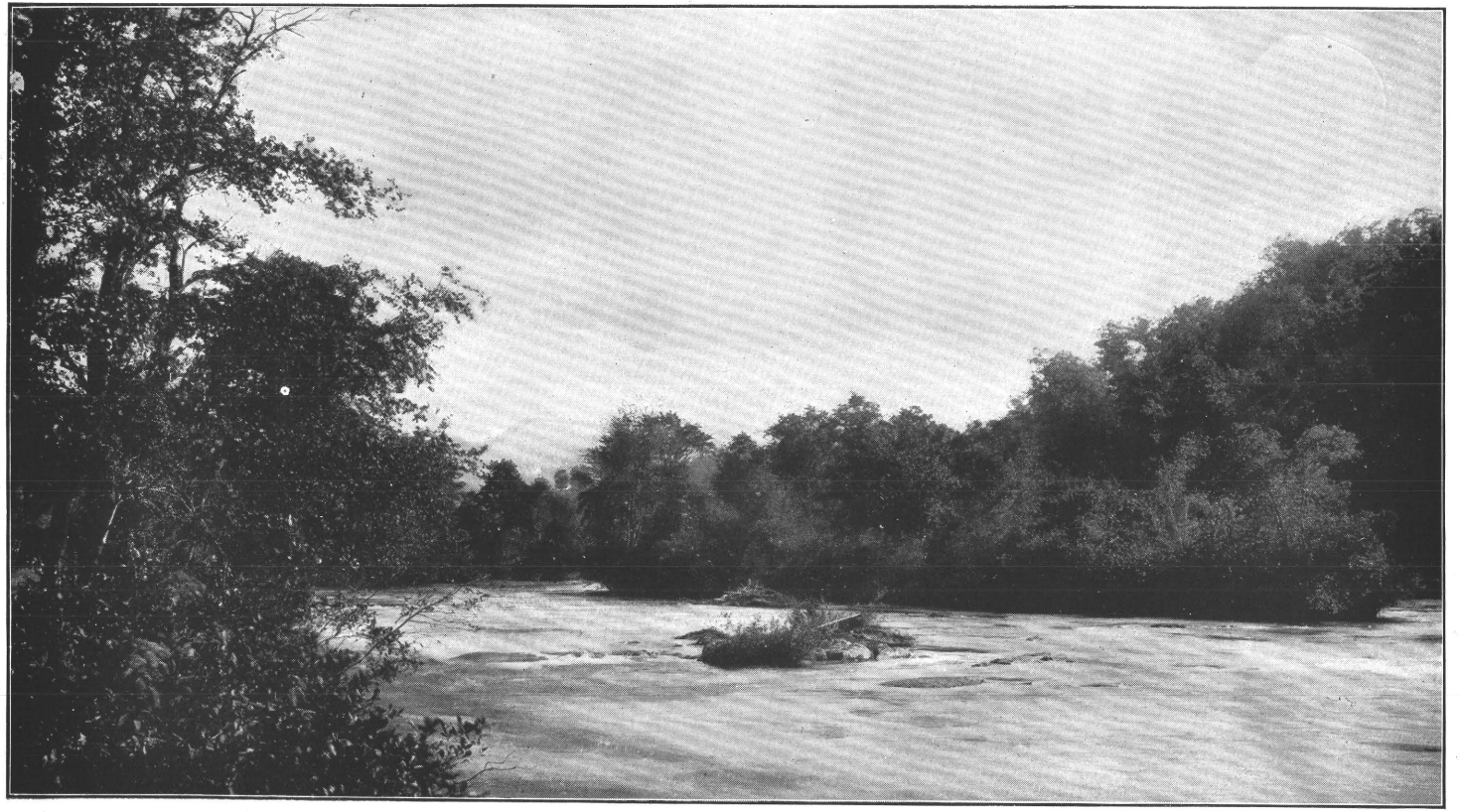
The mineral resources are practically untouched and comparatively unknown, but they are evidently important and varied. Gold, corundum, asbestos, marble, talc, kaolin, ocher, iron, and mica are known to exist. The whole region is sparsely inhabited. Water powers are very numerous, though few are developed, and most of these on only a small scale, for gristmills and sawmills. The large undeveloped powers on the lower parts of the streams are well distributed and are very valuable for manufacturing purposes. After the rivers leave the mountain region and flow across the broad, elevated plains, large falls frequently occur, some of which have in recent years been developed and have proved to be most lucrative investments.

The results of the measurements upon the streams in this region are given in the following tables, arranged in chronologic order:[a]

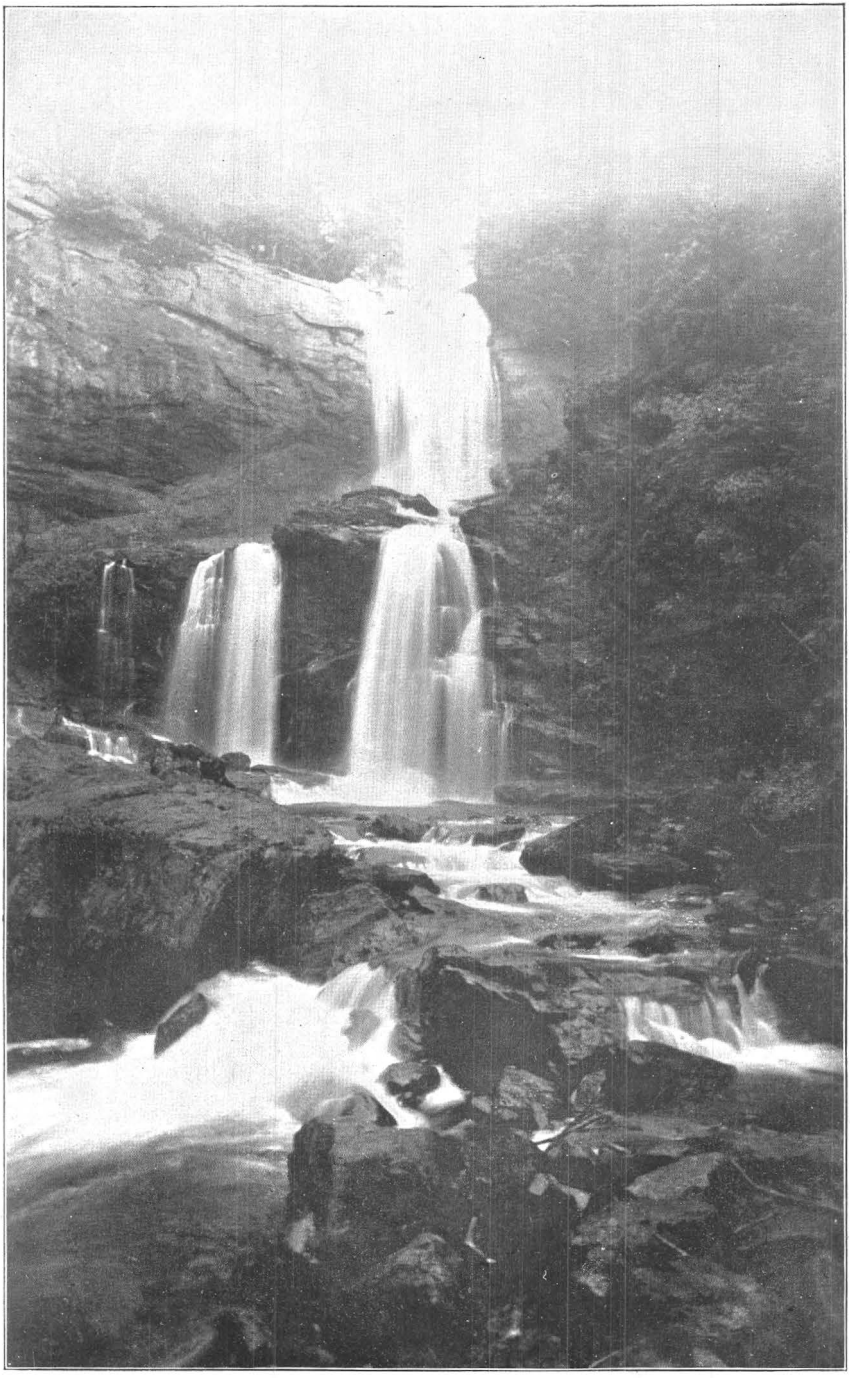
Discharge measurements of tributaries of Tennessee River north of Hiwassee River.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1901.				*Feet.*	*Sec.-ft.*
Feb. 18	Conasauga Creek	Near Cambria, Tenn	B. M. Hall and assistants.		101
Feb. 19	Tellico River	1¼ miles above mouth	do		316
Do	Little Tennessee River.	½ mile below mouth of Tellico River.	do	3.10	4,774
Feb. 20	Little River	1 mile above mouth	do		374
Feb. 21	West Fork of Little Pigeon River.	At bridge just above mouth	do		133

[a] In making the measurements recorded in these tables bench marks were established and measurements were made, by means of a steel tape, of the distance from the bench mark to the surface of the water. An increase in the gage height, therefore, means a lowering of the water surface and a corresponding decrease in the discharge of the stream, the reverse of the results at the regular stations of the Survey, where gages are installed and where an increase in gage height represents an increase in the discharge of the stream.



TUCKASEGEE RIVER NEAR DILLSBORO, N. C.



TUCKASEGEE FALLS, NORTH CAROLINA.

Discharge measurements of tributaries of Tennessee River north of Hiwassee River—Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1901.				*Feet.*	*Sec.-ft.*
Feb. 21	Little Pigeon River	At bridge just above junction with West Fork of Little Pigeon.	B. M. Hall and assistants.		167
Feb. 22	East Fork of Little Pigeon River.	Near mouth	do		[a]30
Do	Cosby Creek	At mouth	do		60
Feb. 23	Big Pigeon River	At bridge above mouth of Cosby Creek.	do		778
Apr. 3	Tellico River	At bridge 1½ miles above mouth.	do		2,580
Do	Little Tennessee River.	McGhee, Tenn	do		30,536
Apr. 4	Little River	Halfway between Louisville and Knoxville, Tenn., at A., K. and N. Ry. bridge.	do		2,012
Sept. 11	Collins River	McMinnville, Tenn	do	2.60	310
Nov. 4	Little Tennessee River.	McGhee, Tenn	do	2.50	2,675
Do	Tellico River	At bridge 1½ miles above mouth.	do		180

[a] Estimated.

Discharge measurements of Hiwassee River and tributaries.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1901.				*Feet.*	*Sec.-ft.*
Jan. 10	Stanley Creek	1 mile above mouth	B. M. Hall and assistants.		49.0
Do	Big Creek	Near mouth	do		86.0
Jan. 11	Noontootly Creek	At foot log ¼ mile from mouth	do		207.0
Do	Toccoa River	At Van Sant's bridge	do	5.05	2,475.0
Do	Skeenah Creek	1 mile above mouth	do		109.0
Jan. 12	Rock Creek	Near mouth	do		132.0
Do	Cooper Creek	Bridge 1 mile above mouth	do		387.0
Do	Toccoa River	1½ miles above mouth of Cooper Creek.	do		396.0
Do	Mill Creek	At mouth	do		122.0
Do	Toccoa River	Just above mouth of Mill Creek.	do		43.0
Jan. 14	Suches Creek	Near mouth	do		64.0
Do	Toccoa River	Just below Suches Creek	do		175.0
Do	Coosa Creek	Bridge about 2½ miles from mouth.	do		75.0
Do	Nottely River	Bridge 1½ miles from Blairsville, Ga.	do	1.45	450.0
Do	Butternut Creek	Just below bridge at mouth	do		32.0
Jan. 15	Arququah Creek	At Choestoe road	do		40.0
Do	Town Creek	½ mile from mouth	do		85.0
Do	Stink Creek	1 mile above mouth	do		48.0
Do	Nottely River	At foot log just above mouth of Stink Creek.	do		131.0
Do	Wolf Creek	On south side of Nottely River	do		55.0
Jan. 16	Young Cone Creek	1 mile above mouth	do		94.0
Do	Ivy Log Creek	½ mile above mouth	do		33.9
Jan. 17	Nottely River	At Thompson's bridge at Ivy Log, Ga.	do	1.20	616.0
Jan. 18	Brasstown Creek	At bridge near mouth	do		149.0
Jan. 21	Hiwassee River	Just above mouth of Hightower Creek.	do		152.0
Do	Bell Creek	At mouth	do		24.0
Do	Hightower Creek	Near mouth	do		116.0
Jan. 22	Hiwassee River	Bridge 1½ miles below Hiwassee, Ga.	do		306.0
Jan. 24	Hemptown Creek	Just above mouth of Youngstone Creek.	do		159.0
Do	Hothouse Creek	About 2 miles above mouth	do		75.0
Jan. 25	Greasy Creek	Near mouth	do		88.0
Jan. 26	Okoee River	Parksville, Tenn	do		1,602.0
Aug. 19	Toccoa River	1½ miles south of Gaddistown, Ga.	do		67.4
Aug. 20	Williams Creek	½ mile south of Gaddistown, Ga.	do		22.8
Do	Nickle Creek	¼ mile south of Gaddistown, Ga.	do		12.8

Discharge measurements of Hiwassee River and tributaries—Continued.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1901.				*Feet.*	*Sec.-ft.*
Aug. 29	Toccoa River	¼ mile southeast of Gaddistown, Ga.	B. M. Hall and assistants.		147.6
Do	Suches Creek	1 mile northeast of Gaddistown, Ga.	do		144.0
Do	Cooper Creek	Near fork between Gaddistown and Blairsville, Ga.	do		251.5
Do	Mulky Creek	do	do		75.0
Do	Nottely River	1 mile southwest of Blairsville, Ga.	do		955.0
Aug. 21	Christopher Creek	2½ miles southeast of Blairsville, Ga.	do		39.1
Do	Arququah Creek	3¾ miles southeast of Blairsville, Ga.	do		96.0
Do	Foun Creek	6 miles southeast of Blairsville, Ga.	do		279.0
Do	Stink Creek	Near Choestoe, Ga	do		167.0
Do	Choestoe Creek	5½ miles southeast of Choestoe, Ga.	do		160.0
Aug. 23	Miller Creek	¼ mile northeast of Blairsville, Ga.	do		87.0
Do	Brasstown Creek	1⅛ miles southwest of Young Harris, Ga.	do		139.0
Aug. 26	Long Bullet Creek	3 miles northwest of Hiwassee, Ga.	do		[a]26.0
Do	Hog Creek	1½ miles northwest of Hiwassee, Ga.	do		42.0
Do	Hiwassee River	1 mile northwest of Hiwassee, Ga.	do		1,039.0
Do	Fodder Creek	3 miles southeast of Hiwassee, Ga.	do		110.7
Do	Hiwassee River	3 miles north of Mountain Scene, Ga.	do		529.8
Do	Cinth Creek	2 miles north of Mountain Scene, Ga.	do		89.0
Aug. 27	Hiwassee River	⅛ mile north of Mountain Scene, Ga.	do		92.0
Do	Owl Creek	1 mile north of Mountain Scene, Ga.	do		87.1
Aug. 21	Fightingtown Creek	8 miles from mouth	do		236.0
Aug. 22	Weaver Creek	2 miles from mouth	do		97.0

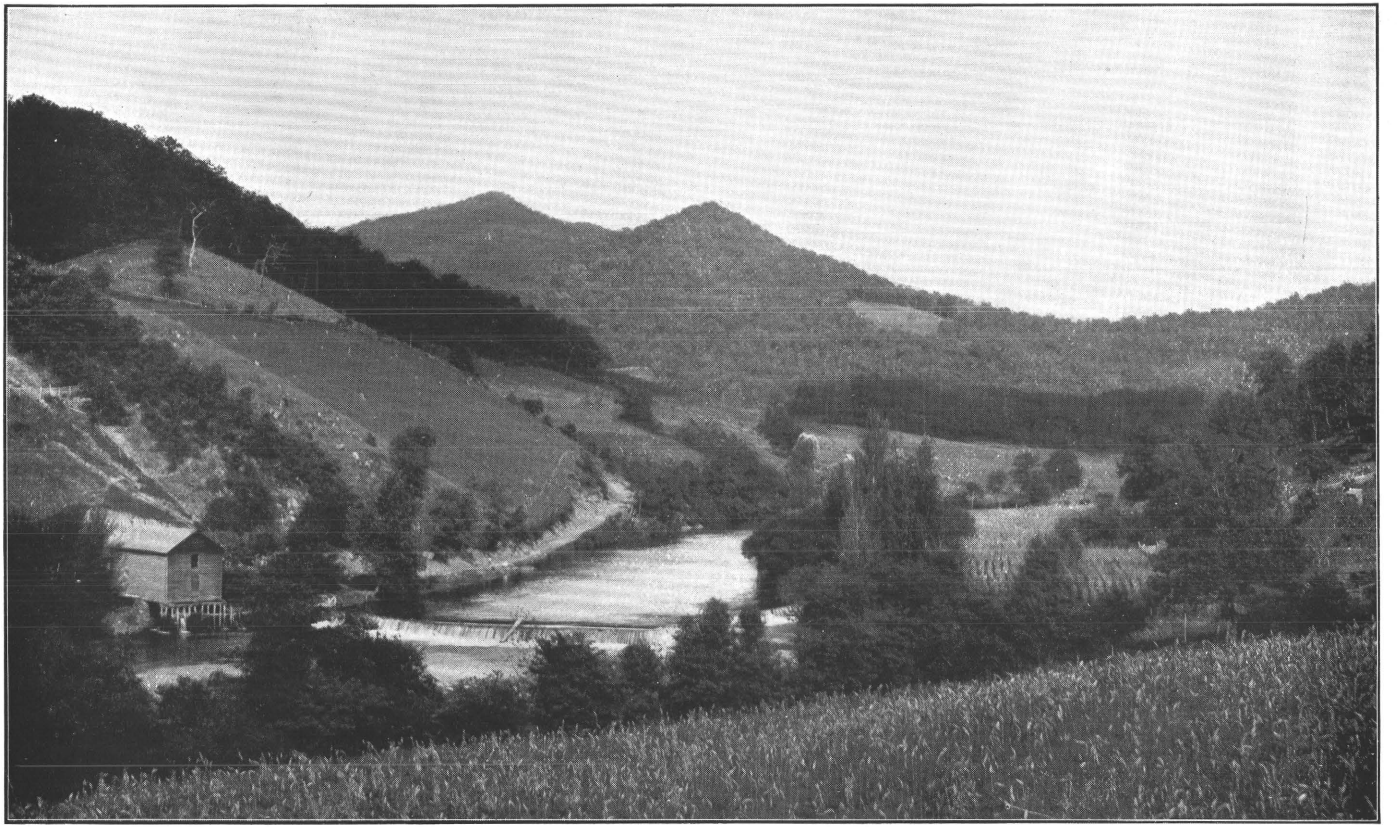
[a] Estimated.

Discharge measurements of Duck and Elk rivers, Tennessee.

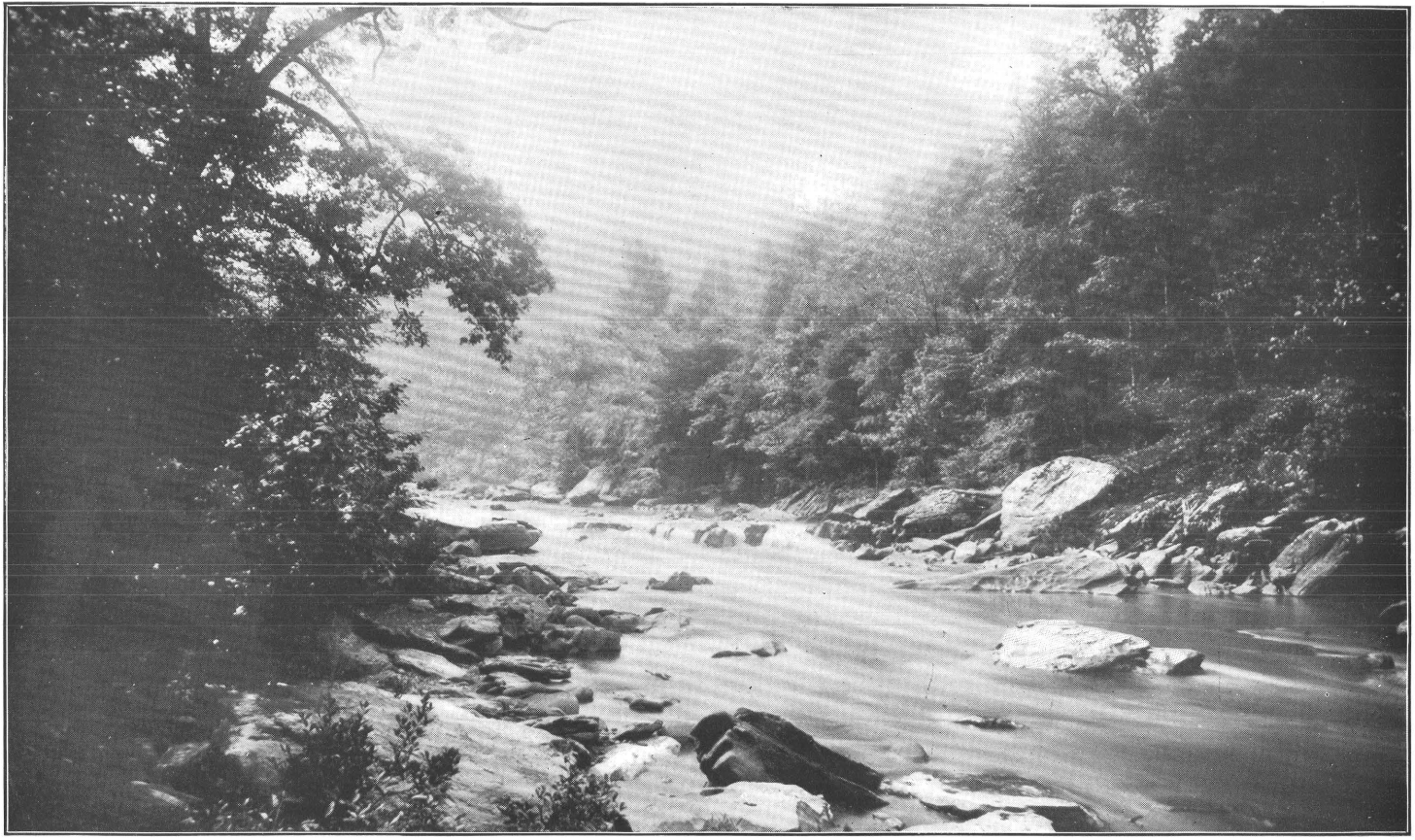
Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Feb. 9	Duck River	Columbia, Tenn	Max Hall	2,418
Do	Elk River	Fayetteville, Tenn	do	1,828
Apr. 19	Duck River	Columbia, Tenn	do	9,504

Discharge measurements of tributaries of Savannah River.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
1901.				*Feet.*	*Sec.-ft.*
Apr. 24	Rocky River	5½ miles northwest of Calhoun Falls, S. C.	B. M. Hall and assistants.		546.0
Aug. 12	do	do	do		448.0
Aug. 13	Little River	5 miles west of Calhoun Falls, S. C.	do	1.35	107.0
Sept. 30	Stekoa Creek	2 miles south of Clayton, Ga.	do		71.0
Do	Mill Creek	do	do		7.9
Oct. 19	Tiger Creek	Tallulah Falls, Ga., ½ mile above mouth.	do		151.0



WATER-POWER DEVELOPMENT ON TUCKASEGEE RIVER NEAR PAINTER, N. C.



OKOEE RIVER NEAR DUCKTOWN, TENN.

Discharge measurements of Flint River and tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Mar. 9	Kinchafoonee Creek	Albany, Ga	B. M. Hall	1,208
Do	Muckalee Creek	1¼ miles above mouth	do	1,777
Do	Blue Spring Creek	4 miles below Albany, Ga	do	95
Mar. 26	Kinchafoonee Creek	Albany, Ga	F. A. Murray	1,920
Do	Muckalee Creek	do	do	3,244
Apr. 17	Flint River	1 mile south of Montezuma, Ga	do	5,099
Apr. 18	Kinchafoonee Creek	Albany, Ga	do	1,741
Do	Muckalee Creek	do	do	2,600
July 18	Flint River	1½ miles east of Montezuma, Ga	do	2,398
July 19	Kinchafoonee Creek	Near Albany, Ga	do	714
Do	Muckalee Creek	do	do	1,001

Discharge measurements of Chattahoochee River and tributaries in Georgia.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Jan. 7	Nancys Creek	7 miles northeast of Atlanta, on Peachtree road.	J. C. Conn	45.9
May 15	Sweetwater Creek	Austell, Ga	K. T. Thomas	188.0
June 25	Chattahoochee River	3½ miles northwest of Gainesville, Ga.	F. A. Murray	1,306.0
Oct. 24	Baldridge Creek	Near Buford, Ga	Max Hall	23.5

Discharge measurements of Chattahoochee River and tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Jan. 12	Yahoola ditch	1 mile east of Dahlonega, Ga	B. M. Hall and assistants.	39.5
Do	Yahoola Creek	2 miles east of Dahlonega, Ga	do	309.2
Do	Chestatee River	5 miles east of Dahlonega, Ga	do	1,477.1
Jan. 13	East Fork of Tessantee Creek.	3 miles northeast of Cleveland, Ga	do	10.3
Do	Dukes Creek	1½ miles southwest of Nacoochee, Ga	do	265.2
Do	Chattahoochee River	Nacoochee, Ga	do	424.0
Do	Bean Creek	1 mile east of Nacoochee, Ga	do	12.3
Do	Chickamauga Creek	3½ miles northeast of Nacoochee, Ga	do	109.8
Jan. 14	Soque River	4 miles south of Soque, Ga	do	132.0
Do	Shoal Creek	¼ mile above mouth	do	50.1
Do	Soque River	7 miles south of Soque, Ga	do	202.2
Jan. 15	Hazel Creek	Demorest, Ga	do	94.8
Do	Whites Creek	7 miles west of Demorest, Ga	do	38.2
Do	North Prong of Mossy Creek.	Mossy Creek, Ga	do	51.1
Do	South Prong of Mossy Creek.	do	do	25.0
Do	Flat Creek	Glades, Ga	do	22.5
Jan. 16	East Prong of Little River.	2½ miles west of Glades, Ga	do	36.4
Do	West Prong of Little River.	4 miles west of Glades, Ga	do	52.4
Do	Wahoo Creek	4 miles east of Price, Ga	do	89.0
Do	Chestatee River	Newbridge, Ga	do	717.2
Aug. 17	Yahoola Creek	Bridge 1 mile northeast of Dahlonega, Ga.	do	241.0
Do	Tate Creek	1 mile southeast of Porter Springs, Ga	do	32.6
Aug. 19	Cane Creek	3⅜ miles northwest of Dahlonega, Ga	do	40.5
Aug. 29	Santee Creek	¼ mile east of Santee, Ga	do	316.8
Do	Chattahoochee River	1 mile west of Nacoochee, Ga	do	605.6
Do	East Tessantee Creek	2 miles north of Cleveland, Ga	do	27.8
Aug. 30	Chestatee River	3 miles southeast of Dahlonega, Ga	do	744.1
Aug. 31	Crooked Creek	2½ miles southwest of Dahlonega, Ga	do	9.0
Do	Chestatee River	Newbridge, Ga	do	1,141.3
Do	Yellow Creek	2 miles southeast of Newbridge, Ga	do	41.0

Discharge measurements of Etowah River and tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Jan. 7	Willieo Creek	¼ mile above mouth	B. M. Hall and assistants.	20.1
Jan. 8	Coopers Sandy Creek	1 mile north of Crabapple, Ga	do	9.0
Do	South Prong of Little River.	2 miles south of Freemansville, Ga	do	21.5
Do	North Fork of Little River.	2 miles north of Freemansville, Ga	do	13.4
Do	Smithwick Creek	½ mile east of Orange, Ga	do	8.2
Do	Buzzard Flopper Creek.	3 miles east of Orange, Ga	do	6.5
Do	Boardtree Creek	1 mile south of Creighton, Ga	do	7.2
Do	Settingdown Creek	Creighton, Ga	do	74.0
Jan. 9	Etowah River	½ mile north of Hightower, Ga	do	512.4
Do	Yellow Creek	6 miles northeast of Hightower, Ga	do	32.0
Jan. 10	Amicalola River	Afton, Ga	do	166.4
Do	East Amicalola River.	Weir, Ga	do	58.3
Jan. 11	Nimblewill Creek	1 mile south of Randa, Ga	do	383.3
Do	Etowah River	5⅛ miles east of Randa, Ga	do	1,881.0
Jan. 17	Cogburris Creek	1½ miles above mouth	do	14.6
Do	Etowah River	Hightower, Ga	do	676.1
Jan. 18	Settingdown Creek	½ mile above mouth	do	178.3
Do	Boardtree Creek	1 mile south of Creighton, Ga	do	9.8
Jan. 19	Willieo Creek	¼ mile above mouth	do	31.0
Aug. 31	Etowah River	1 mile west of Auraria, Ga	do	173.0

Discharge measurements of Cahaba River and tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Jan. 28	Hawkins Spring	¼ mile from Hawkins Station	K. T. Thomas	15.8
Jan. 29	Cahaba River	Sydenton, Ala	do	549.0
Mar. 28	Valley Creek	Adjers Station, Ala	J. R. Hall	378.0
Do	Blocton Creek	Blocton, Ala	do	107.0
Mar. 29	Cahaba River	¼ mile south of Sydenton Station, Ala	do	1,117.0
Do	Buck Creek	¼ mile above mouth	do	179.0
Apr. 25	Cahaba River	2 miles east of Harrell, Ala	do	6,560.0

Discharge measurements of Tombigbee River and tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Feb. 16	Tombigbee River	Waverly, Miss	K. T. Thomas	6,726
Feb. 18	Luxapelila Creek	Columbus, Miss	do	957
Mar. 7	Yalabusha River	Grenada, Miss	do	1,336
Mar. 11	Luxapelila Creek	Columbus, Miss	do	2,459
Apr. 15	Big Black River	1 mile east of Goodman, Miss	do	614
Apr. 16	Luxapelila Creek	Columbus, Miss	do	873
June 26	do	do	do	109
Oct. 31	do	do	do	126

Discharge measurements of tributaries of Mississippi River.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Feb. 14	Sunflower River	Baird, Miss	K. T. Thomas	3,761
Feb. 15	Sakatouchee River	Mhoon Valley, Miss	do	559

Discharge measurements of Tallapoosa River and tributaries.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Jan. 7	Tallapoosa River	2 miles from Tallapoosa, Ga	Max Hall	329
Feb. 11	Wind Creek	About 4 miles above mouth	J. R. Hall	66
Do	Saugahatchee Creek	Thaddeus, Ala	do	453
Feb. 13	Blue Creek	½ mile from Susanna, Ala	do	117
Do	Chenehatchee Creek	3 miles above mouth	do	80
Feb. 27	Kowaliga Creek	Kowaliga, Ala	do	154
Mar. 5	Emuckfaw Creek	Near Zana P. O., Ala	do	113
Mar. 11	Moores Creek	1½ miles north of Dudleyville, Ala	do	29
Mar. 12	Chattahaspa Creek	1 mile south of Patillos crossroads, Chambers County, Ala.	do	203
Do	Cohoasoncsa Creek	2½ miles below and west of Milltown, Ala.	do	122
Do	Highpine Creek	½ mile south of Chambers and Randolph County line.	do	89
Do	Beaverdam Creek	1 mile north of Lovina, Ala	do	30
Mar. 13	Cornhouse Creek	Near Level Roads, Ala	do	31
Do	Wildcat Creek	Near Gay P. O., Ala	do	32
Do	Tallapoosa River	About 3 miles below confluence of Big and Little Tallapoosa rivers, at Blakes Ferry.	do	2,400
Do	Crooked Creek		do	183
Do	Hurricane Creek	1 mile north of Almond, Ala	do	29
Oct. 21	Tallapoosa River	Near Tallapoosa, Ga	Max Hall	119
Do	do	do	do	96

Discharge measurements of tributaries of Coosa River in Alabama.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Apr. 5	Choccolocco Creek	1½ miles north of Jenifer, Ala	J. R. Hall	1,170.0
Oct 16	Big Wills Creek	2 miles north of Attalla, Ala	F. A. Murray	107.3
Do	do	do	do	106.8

Discharge measurements of tributaries of Oostanaula River.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Jan. 7	Mountaintown Creek.	3½ miles from Ellijay, Ga	B. M. Hall and assistants.	162.0
Do	Ellijay River	Ellijay, Ga	do	165.0
Jan. 8	Cartecay River	do	do	250.0
Do	do	Cartecay, Ga	do	207.0
Do	Anderson Creek	1 mile above mouth	do	37.0
Jan. 9	Tickanetley River	1 mile above mouth of Anderson Creek	do	43.5
Jan. 28	Jacks River	Near its junction with Conasauga River.	do	186.0
Do	Conasauga River	1 mile above mouth of Jacks River	do	119.0
Do	Sheets Creek	Just above mouth	do	12.0
Jan. 29	Sumach Creek	At junction of North and South prongs.	do	58.3
Do	North Prong of Sumach Creek.	Near junction of North and South prongs.	do	19.8
Do	South Prong of Sumach Creek.	do	do	38.5
Do	Mill Creek	Near Dunn, Ga	do	41.8
Do	Holly Creek	Near East Mountain, Ga	do	107.0
Do	Rock Creek	Ramsay, Ga	do	41.0
Aug. 19	Talking Rock Creek	Talking Rock, Ga	do	215.0
Do	Talona Creek	¼ mile above mouth	do	714.0

INDEX TO PAPERS NOS. 62 AND 63.

A.

Page.

Abbe, Cleveland, jr., acknowledgments to 11
Agriculture, extent and character of 39, 41
Amicalola River, measurement of 180
Anderson Creek, measurement of 181
Ararat River, features of 169
measurements of 164
Arququah Creek, measurements of 177, 178
Atcheson Creek, measurements of 62
Avery Creek, measurement of 128

B.

Bald Creek, measurements of 109
Bald Mountain Creek, measurements of 109
Baldridge Creek, measurement of 179
Balds, occurrence and character of 20–21
Balsam, occurrence and character of 26
Balsam fir (wind-dwarfed), view showing 26
Balsam Mountains, features of 13
highest peaks in 14
Bark industry, extent and injury of 26
Bean Creek, measurement of 179
Bell Creek, measurement of 177
Bear Creek (Middle Fork Holston), features of 77
measurements of 73
Bear Creek (Nolichucky), measurements of 108
Bear Creek (North Toe), water powers of 113
Beaver Creek (New), measurement of 172
water power on 173
Beaver Creek (Nolichucky), measurements of 108
Beaver Creek (North Toe), water powers of 113
Beaverdam Creek (French Broad), features of 135
measurements of 128
Beaverdam Creek (Laurel Fork Holston), features of 65–66
Beaverdam Creek (South Fork Holston), measurements of 62
Beaverdam Creek (Tallapoosa), measurement of 181
Beaverdam Creek (Watauga), features of 92–93
measurements of 86
Beech Creek, features of 92
measurements of 86
Beidelmans Creek. *See* Sinking Creek (Holston).
Big Creek (French Broad), features of 129
Big Creek (Hiwassee), measurement of 177
Big Creek (Nolichucky), measurements of 109
Big Black River, measurement of 180
Big Bugaboo Creek, measurement of 164
Big Dry Run, measurement of 86
Big Elkin River, features of 137–168
measurements of 164
Big Ivy River, measurements of 128
Big Laurel Creek (French Broad), features of 130–131
measurements of 128
Big Laurel Creek (New), measurements of 174
Big Pine Creek, features of 131
measurements of 128
Big Pigeon River, measurement of 177
Big Rock Creek (Nolichucky), measurements of 108
Big Rock Creek (North Toe), features of 113–114
Big Wills Creek, measurements of 181
Black Mountains, features of 13
highest peaks in 15
lumbering in 28
name of, derivation of 21
view in 30
Blevins Creek, measurement of 86
Blocton Creek, measurement of 180
Blowing Rock, N. C., escarpment of Blue Ridge at, view showing 16
Blue Creek, measurement of 181
Blue Ridge, escarpment of, view of 16
features of 12–13, 17
rivers rising in 17
Blue Spring Creek, measurement of 179
Boardtree Creek, measurements of 180
Boone Fork of Watauga River, features of 94–95
measurements of 86
Bowlems Creek, measurements of 109
Boylston Creek, measurement of 128
Branch, L. V., acknowledgments to 11
Brasstown Creek, measurements of 177, 178
Broad River, drainage basin of 139–140
features of 19
forests in basin of 140
measurements of 141
minerals in basin of 140
rainfall in basin of 140
tributaries of, features of 143–146
tributaries of, measurements of 143
water powers of 142
Brown Creek, measurements of 109
Brush Creek (Nolichucky), measurements of 108
Brush Creek (Watauga), features of 87
measurements of 85

Page.

Brushy Fork of Cone Creek (Watauga), measurement of ... 86
Buck Creek (Cahaba), measurement of ... 180
Buck Creek (Catawba), features of ... 152–153
measurements of ... 151
Buffalo Creek (Broad), measurement of ... 143
Buffalo Creek (New), measurements of ... 174
Buffalo Creek (Watauga), features of ... 87–88
measurements of ... 85
Buncombe County, N. C., features of ... 118–120
Butternut Creek, measurement of ... 177
Buzzard Flopper Creek, measurement of ... 180
Byars Creek, features of ... 75–76
measurements of ... 73

C.

Cahaba River, measurements of ... 180
tributaries of, measurements of ... 180
Cane Branch (Nolichucky), measurements of ... 109
Cane Creek (Broad), measurement of ... 143
Cane Creek (Catawba), features of ... 155
measurements of ... 151
Cane Creek (Chattahoochee), measurement of ... 179
Cane Creek (Nolichucky), measurements of ... 108
view of ... 105
Cane Creek (North Toe), features of ... 113
Caney Creek, measurement of ... 128
Caney River, features of ... 114–115
measurements of ... 109
Carlocks Creek, features of ... 75
Cartecay River, measurements of ... 181
Catawba River, drainage basin of ... 147–148
falls on, view of ... 146
features of ... 19
floods in, view showing effects of ... 148
flow of, minimum ... 150
forests in basin of ... 148
hillside wash in valley of, view showing ... 148
measurements of ... 148–149
rainfall in basin of ... 148
tributaries of, features of ... 152–158
tributaries of, measurements of ... 151–152
water powers of ... 150–151
Catawba River, North Fork, features of ... 153
measurements of ... 151
Cathey Creek (Broad), measurement of ... 143
Cathey Creek (French Broad), measurement of ... 128
Cattail Branch, measurements of ... 109
Cedar Creek, features of ... 74
measurement of ... 73
Center Creek, features of ... 152
Chattahaspa Creek, measurement of ... 181
Chattahoochee River, measurements of ... 179
tributaries of, measurements of ... 179
Cheever Improvement Company, forests owned by ... 29
Chenehatchee Creek, measurement of ... 181
Chestatee River, measurements of ... 179
Chestnut, occurrence of ... 27
Chickamauga Creek, measurement of ... 179
Chilhowie Creek, features of ... 75
Choccolocco Creek, measurement of ... 181

Page.

Choestoe Creek, measurement of ... 178
Christopher Creek, measurement of ... 178
Cinth Creek, measurement of ... 178
Clay deposits, views showing ... 34
Clear Creek, features of ... 152
measurements of ... 151
Climate, features of ... 22–23
Clingman, General, quoted ... 31
Cloudland, N. C., features of ... 113–114
Cocke County, Tenn., features of ... 121–123
Cogburris Creek, measurement of ... 180
Cohoasoncsa Creek, measurement of ... 181
Colbert Creek, measurements of ... 109
Collins River, measurement of ... 177
Conasauga Creek, measurement of ... 176
Conasauga River, measurement of ... 181
Conn, J. C., acknowledgments to ... 11
Cooper Creek, measurements of ... 177, 178
Coopers Sandy Creek, measurement of ... 180
Coosa Creek, measurement of ... 177
Coosa River, tributaries of, measurements of ... 181
Cornhouse Creek, measurement of ... 181
Cosby Creek, measurement of ... 177
Cove Creek (Broad), measurements of ... 143
Cove Creek (Watauga), features of ... 93–94
measurements of ... 86
Cowee Mountains, features of ... 13
Crabtree Creek (Nolichucky), measurements of ... 108
Crabtree Creek (North Toe), water powers of ... 113
Craggy Range, highest peaks in ... 15
Cranberry Creek, measurement of ... 86
Crib Creek, features of ... 152
measurements of ... 151
Crooked Creek (Chattahoochee), measurement of ... 179
Crooked Creek (Tallapoosa), measurement of ... 181
Cullasagee Creek, N. C., falls of, view of ... 174
Curtis, N. C., acknowledgments to ... 11
Curtis Creek, measurements of ... 151

D.

Dam, splash, view of ... 108
Dark Ridge Creek, measurement of ... 86
Davidson River, measurements of ... 128
Deforestation, effects of ... 29–30, 31–33, 58, 74
effects of, views showing ... 32, 34, 148
Denton Valley Creek, features of ... 61
measurements of ... 53
Doe Creek, features of ... 90
measurements of ... 86
Doe River, features of ... 88–89
measurements of ... 85–86
Doe River Valley, view of ... 88
Drainage basins, map showing ... 14
Dry Creek, features of ... 55
Duck River, measurements of ... 178
Dukes Creek, measurement of ... 179
Dutch Creek, features of ... 94
measurements of ... 86

E.

East Amicalola River, measurement of ... 180
East Branch or Fork of any stream, *see* the stream.

Page.
Elk Creek (New), measurements of 170, 172
water power on 173
Elk Creek (Watauga), features of 91-92
measurements of 86
view of 90
Elk Creek (Watauga), North Fork, measurements of 86
Elk Creek (Watauga), South Fork, measurements of 86
Elk Creek (Yadkin), features of 165
measurements of 164
Elk Falls, N. C., view of 90
Elk Fork Creek, measurements of 109
Elk River, measurement of 178
Elk Shoal Creek, measurement of 109
Ellijay River, measurement of 181
Empire Company, forests of and lumbering by 27
Emuckfaw Creek, measurement of 181
Enoree River, measurement of 143
Erosion, extent of 29, 31-32
effects of, views showing 32, 34, 148
Etowah River, measurements of 180
tributaries of, measurements of 180

F.

Fall Creek, measurement of 138
Fifteenmile Creek, features of 62
measurements of 53
Fightingtown Creek, measurement of 178
Fires, destruction by 29-30
First Broad River, features of 143-144
measurements of 143
Fishdam Creek, features of 58
measurements of 53
Fisher River, features of 168-169
measurements of 164
Fish Spring, Tenn., features of 82
Flannery Fork, measurements of 172
Flat Creek (Chattahoochee), measurement of 179
Flat Creek (French Broad), features of .. 134-135
measurements of 128
Flint River, measurements of 179
tributaries of, measurements of 179
Floods, destruction by 32-33
effects of 32-33
effects of, view showing 34, 106, 148
Fodder Creek, measurement of 178
Fogey Creek, measurements of 86
Forests, destruction of 26-27, 28-29
extent and character of ... 20, 21, 25-30, 82-83
fires in 29-30
value of 31-32
views showing 20, 26
Forge Creek, measurement of 86
Foun Creek, measurement of 178
Fox Creek, measurements of 170
French Broad River, drainage basin of .. 115-123
features of 18-19
measurements of 124
rainfall in basin of 123
streams southwest of, features of .. 175-176
transportation facilities in basin of .. 124
tributaries of, features of 129-135
tributaries of, measurements of 127-128
Page.
French Broad River, views of 120, 124
water powers of 125-127
French Broad River, East Fork, measurement of 128
French Broad River, Middle Fork, measurement of 128
French Broad River, North Fork, measurements of 127
French Broad River, South Fork, measurement of 128
French Broad River, West Fork, measurements of 128

G.

Gaging stations, location of 35
map showing location of 14
Gap Creek (New), measurement of 172
Gap Creek (Watauga), features of 88
measurements of 85
Geology, features of 15-17
Gneiss (decomposed), erosion in, view showing 32
Grandfather Mountain, elevation of 153
features of 21-22, 81-82
forests of 21, 26
views of 22, 26, 38
Grandmother Mountain, elevation of 153
Grassy Creek, measurements of 108
Graves, E., acknowledgments to 11
Greasy Creek, measurement of 177
Green River, features of 145-146
measurements of 143
Grose Creek, features of 68
measurements of 63

H.

Hall, B. M., acknowledgments to 11, 175
Hall, J. R., acknowledgments to 11
Hall, M., acknowledgments to 11
Hall, W. E., acknowledgments to 11
Halls Creek, features of 75
measurement of 73
Hard woods, occurrence and character of .. 26, 28
Hatcher Creek, features of 55
measurement of 53
Hawkins Spring, measurement of 180
Hayes Creek, features of 132
Hazel Creek, measurement of 179
Helton Creek, features of 175
measurements of 174
Hemptown Creek, measurement of 177
Henderson County, N. C., features of .. 117-118
Hensons Creek (Nolichucky), measurement of 109
Hensons Creek (North Toe), low-water flow of 113
water powers of 113
Hickory Nut Creek, measurement of 143
view of 140
Hickory Nut Gap, N. C., view of 140
Highpine Creek, measurement of 181
Hightower Creek, measurement of 177
Highways. *See* Roads.
Hillside slopes, agriculture on 29, 30
Hillside wash. *See* Erosion.

Page.

Hiwassee River, measurements of 177,178
tributaries of, measurements of.... 177-178
Hog Creek, measurement of..... 178
Hogthief Creek, features of 74
measurements of..... 73
Hogtrough Creek, features of 68-69
measurements of..... 63
Hollins Creek, measurement of 143
Hollow Poplar Creek, features of..... 110
measurements of..... 108
Holly Creek, measurement of 181
Holmes, J. A., acknowledgments to..... 9,11
Holston River, agriculture in basin of... 41
drainage basin of..... 36-40
features of..... 18
lumber in basin of..... 41
minerals in basin of 41
rainfall in basin of..... 40
transportation facilities in basin of.. 41-42
Holston River, Middle Fork, drainage basin of 69-70
measurements of..... 70
tributaries of, features of..... 74-77
tributaries of, measurements of..... 73
water powers of..... 70-73
Holston River, South Fork, drainage basin of 42-46
fall or slope of 42
forests in basin of 47
measurements of..... 48
minerals in basin of 47
rainfall in basin of 47
transportation facilities in basin of .. 47
tributaries of, features of..... 53-69
tributaries of, measurements of... 53, 62-63
water powers of..... 48-53
Hominy Creek, measurements of 128
Horse Creek (New), measurements of... 174
Horse Creek (Nolichucky), measurements of 109
Hothouse Creek, measurement of..... 177
Hot Springs, N. C., features of 121
Hungry Mother Creek, features of..... 76
measurements of 73
Huntsdale, Tenn., development of..... 28
Hurricane Creek, measurement of 181
Huttons Branch, features of 75
measurements of..... 73

I.

Indian Creek, features of 54
Ivy Log Creek, measurement of 177
Ivy River, features of 132-133

J.

Jack Creek, measurements of..... 108
Jacks River, measurement of 181
Jacobs Creek, features of 60
measurements of 53
Jarrett Creek, measurement of..... 151
Jim Scot Branch, measurements of..... 63
Jonah Creek, features of 58
measurements of 53
John River, features of..... 157-158
measurements of 152
Johnson County Cove, features of..... 38

K.

Page.

Keith, A., quoted on geology of region ... 15-17
quoted on soils and deforestation 31-32
Kentucky Fork of North Toe River, measurement of 109
Kinchafoonee Creek, measurements of .. 179
King Creek, measurement of..... 128
Kowaliga Creek, measurement of 181

L.

Laurel Branch, features of 129
Laurel Creek, features of..... 93,94
Laurel Creek, lower. *See* Lower Laurel Creek.
Laurel Creek, upper. *See* Upper Laurel Creek.
Laurel Fork of Doe River, features of ... 89
measurements of 85
Laurel Fork of Holston River, features of. 63-67
measurements of 62
Lees Creek, measurements of 128
Lime, manufacture of 43,46
Linville Gap, elevation of 153
Linville Improvement Company, lands owned by 21-22
Linville River, falls of, view of..... 154
features of..... 153-155
measurements of 151
Little River (Chattahoochee), East Prong, measurement of..... 179
Little River (Chattahoochee), West Prong, measurement of..... 179
Little River (Etowah), North Prong, measurement 180
Little River (Etowah), South Prong, measurement of..... 180
Little River (French Broad), measurements of 128
Little River (New), measurements of.... 170
Little River (Savannah), measurement of 178
Little River (Tennessee), measurements of..... 176,177
Little Bald Mountain Creek, measurements of 109
Little Crabtree Creek (Nolichucky), measurements of..... 109
Little Crabtree Creek (South Toe), features of 114
Little Doe River, features of 88-89
measurements of 85
Little Elk Creek, measurement of 86
Little Pigeon River, measurement of.... 177
Little Pigeon River, East Fork, measurement of 177
Little Pigeon River, West Fork, measurement of 176
Little Pine Creek, features of 132
measurements of..... 128
Little Tennessee River, measurements of..... 176,177
Locust Creek, measurements of..... 109
Long Creek, features of 129
Long Bullet Creek, measurement of 178
Louis Fork of Yadkin River, features of..165-166
measurements of 164
Lower Creek, features of..... 158
measurements of..... 152

Page.

Lower Laurel Creek, measurements of .. 86
Lumbering, extent and methods of 25–29
Luxapelila Creek, measurements of 180

M.

Madison County, N. C., features of 120–121
Maple Creek, measurement of 143
Map, drainage basin and gaging stations. 14
mountain ranges and drainage 11
Martin Creek, measurements of 108
Meat Camp Creek, measurements of..... 172
water power on 173
Middle Creek, measurements of..... 109
Middle Fork or Branch of any stream, *see* the stream.
Middle Saluda River, features of..... 137
measurements of 138
Mill Creek (Catawba), measurements of 151
Mill Creek (Hiwassee), measurement of..... 177
Mill Creek (Oostanaula), measurement of..... 181
Mill Creek (Savannah), measurement of. 178
Mill Creek (South Fork Holston) features of..... 68
measurements of 63
Mill Creek (Watauga), features of..... 90–91
measurement of 86
Miller Creek, measurement of..... 178
Mills River, measurements of..... 128
Mineral resources, character and extent of..... 33
Mitchell, Professor, quoted 21
Mitchell River, features of..... 168
measurements of 164
Moody Mill Creek, measurement of..... 86
Mooneyham Branch, features of 129
Moores Creek, measurement of 181
Morganton Improvement Company, forests owned by 29
Morrills Creek, features of..... 55–56
Mossy Creek, North Prong, measurement of..... 179
Mossy Creek, South Prong, measurement of..... 179
Mountain Creek, measurements of..... 143
Mountaineers, homes of 30
homes of, views showing..... 30
Mountains, elevations of..... 12
geology of..... 15–17
physiography of..... 11–15
Mountain Island Shoal, North Carolina, view of..... 124
Mountaintown Creek, measurement of .. 181
Mount Mitchell, features of 21
Muckalee Creek, measurements of..... 179
Mud Creek, measurement of..... 128
Muddy Creek, measurements of 151
Mulberry Creek (Catawba), measurements of 152
Mulberry Creek (New), measurement of. 172
Mulberry River, features of..... 166–167
measurements of..... 164
Mulky Creek, measurement of 178
Myers, E. W., acknowledgments to 11

N.

Page.

Nantahala Mountains, mean elevation of. 13
Nancys Creek, measurement of 179
New River, features of ..... 169–170.
measurements of..... 170
tributaries of, features of..... 170–175
tributaries of, measurements of..... 170
New River, East Fork, measurements of. 172
New River, Middle Fork, measurements of..... 172
water power on..... 173
New River, North Fork, features of..... 173
measurements of..... 174
tributaries of, measurements of..... 174
water powers in basin of..... 174
New River, South Fork, features of..... 171–172
measurements of..... 172
tributaries of, measurements of..... 172
water powers in basin of..... 173
New River, West Fork, measurement of. 172
Newell, F. H., letter of transmittal by... 9
Newfound Creek, features of..... 135
measurements of 128
Nickle Creek, measurement of..... 177
Nimblewill Creek, measurement of 180
Nolichucky River, drainage basin of... 105–106
features of..... 18
forests in basin of 106
measurements of 107
minerals in basin of 106–107
rainfall in basin of..... 106
water powers of..... 107
tributaries of, features of..... 110–115
tributaries of, measurements of..... 108–109
views of 106
Noontootly Creek, measurement of 177
North Branch or Fork of any stream, *see* the stream.
North Indian Creek, features of..... 110
measurements of 108
North Saluda River, features of..... 136–137
measurements of 138
North Toe River, features of 111–112
measurements of 108
tributaries of, features of 112–114
Nottely River, measurements of..... 177, 178

O.

Oconalufty Valley, view of..... 174
Okoee River, measurement of..... 177
view of..... 178
Old Field Creek, measurement of..... 172
Oostanaula River, tributaries of, measurements of 181
Owl Creek, measurement of..... 178

P.

Pacolet River, measurement of..... 143
Paddy Creek, features of 153
measurements of 151
Pawpaw Creek, measurement of 128
Peach Bottom Creek, measurements of.. 170
Pedee River. *See* Yadkin River.
Physiography, features of..... 11–15
Pigeon Creek, measurements of..... 108
Pigeon Roost Creek (Nolichucky), measurements of 108

Page.

Pigeon Roost Creek (North Toe), features of ... 113
Pinchot, Gifford, reference to ... 25
Pine, forest of, view showing ... 26
Plant growth, character and extent of ... 31
density of, view showing ... 30
Plumtree Creek (Nolichucky), measurement of ... 109
Plumtree Creek (North Toe), water powers of ... 113
Pomer Creek, features of ... 69
measurements of ... 63
Poplar, forest of, view showing ... 26
occurrence of ... 27
Powdermill Creek, features of ... 113
Prather Creek, measurement of ... 172
Precipitation, extent and character of ... 23–25
Price Creek, measurements of ... 109
Pulp mills, wood cut for ... 28
Puzzle Creek, measurement of ... 143

R.

Railroads, names and location of ... 20, 25, 27, 28, 29, 47, 58, 83
See also Transportation.
Rainfall. *See* Precipitation.
Reddie River, features of ... 166
measurements of ... 164
Reedy Patch Creek, measurement of ... 143
Reems Creek, features of ... 135
measurements of ... 128
Rhododendrons, occurrence and character of ... 26
thicket of, view showing ... 26
Richland Valley, view of ... 20
Riddle Creek, features of ... 58
measurements of ... 53
Ritter Company, forests of and lumbering by ... 27–28
Rivers, general features of ... 17–20
Roads, character of ... 20, 33–34
views of ... 34, 36, 38
Roan Creek, features of ... 89–91
measurements of ... 86
Roan Mountain, features of ... 21
Roaring Creek (Nolichucky), measurement of ... 109
Roaring Creek (North Toe), features of ... 113
Roaring River, features of ... 167
measurements of ... 164
Robersons Creek, measurement of ... 143
Rock Creek (French Broad), features of ... 129
Rock Creek (Hiwassee), measurement of ... 177
Rock Creek (Nolichucky), measurements of ... 108, 109
Rock Creek (Oostanaula), measurement of ... 181
Rock disintegration, extent of ... 31–32
Rockhouse Creek, measurements of ... 86
Rocky bed of mountain streams, view showing ... 105
Rocky River, measurements of ... 178
Rosenbaums Creek, features of ... 67
Rush Creek, features of ... 67
measurements of ... 63
Run-off, effect of sinks on ... 39–40, 43

S.

Page.

St. Clair Creek, features of ... 68
measurements of ... 63
Sakatouchee River, measurement of ... 180
Saluda River, features of ... 19–20, 135–138
measurements of ... 138
tributaries of, measurements of ... 138
Sand deposits, views showing ... 34
Sandymush Creek, features of ... 134
measurements of ... 128
Santee Creek, measurement of ... 179
Sapphire country, N. C., topography in, view showing ... 24
Saugahatchee Creek, measurement of ... 181
Savannah River, tributaries of, measurements of ... 178
Sawmill and gristmill, combined, view of ... 108
Scadin, R. H., acknowledgments to ... 11
Scenery, features of ... 20–22
Second Broad River, features of ... 144–145
measurements of ... 143
Settingdown Creek, measurements of ... 180
Shady Valley, features of ... 38, 65–66
Sharp Creek, features of ... 58–59
measurements of ... 53
Sheets Creek, measurement of ... 181
Shell Creek, measurement of ... 85
Shelton Laurel Creek, features of ... 131
Shoal Creek, measurement of ... 179
Shutin Creek, features of ... 130
measurement of ... 128
Silver Creek, measurements of ... 151
Sinking Creek (South Fork Holston), features of ... 56–57
measurements of ... 53
Sinking Creek (Watauga), features of ... 87
measurements of ... 85
Sinks, occurrence and features of ... 39, 43, 78, 87
Skeenah Creek, measurement of ... 177
Skyuka Falls, N. C., view of ... 24
Smithwick Creek, measurement of ... 180
Smoky Mountains, features of ... 13–14
highest peaks in ... 14
Snow Creek (Nolichucky), measurement of ... 108
Snow Creek (North Toe), water powers of ... 113
Soil and vegetation, character and extent of ... 30–33
Soque River, measurements of ... 179
South Branch or Fork of any stream, *see* the stream.
South Indian Creek, features of ... 110
measurements of ... 108
South Saluda River, features of ... 137–138
measurements of ... 138
South Toe River, features of ... 114
measurements of ... 109
Splash dam, view of ... 108
Spring Creek (French Broad), features of ... 130
measurements of ... 128
Spring Creek (South Fork Holston), features of ... 59–60

Page.

Spring Creek (South Fork Holston), measurements of ... 53
Springs, occurrence and character of ... 19, 21, 39-40, 82
Sprucepine, N. C., road near, view of ... 36
Squirrel Creek (Nolichucky), measurement of ... 109
Squirrel Creek (North Toe), features of ... 113
Staleys Creek, features of ... 76-77
measurement of ... 73
Stanley Creek, measurement of ... 177
Steel Creek, features of ... 157
measurement of ... 152
Stekoa Creek, measurement of ... 178
Stink Creek, measurements of ... 177, 178
Stock raising, extent of ... 30-31, 41, 47
Stokes, H. G., acknowledgments to ... 11
Stony Creek (Watauga), features of ... 89
measurements of ... 86
Stony Creek (Yadkin), features of ... 165
measurements of ... 164
Stream flow, relation of forests to ... 30, 31-33
Stream measurement, methods of ... 34, 48
Suches Creek, measurements of ... 177, 178
Sugar Mountain, elevation of ... 153
Sumach Creek, measurement of ... 181
Sunflower River, measurement of ... 180
Swannanoa Rapids, view of ... 118
Swannanoa River, measurement of ... 128
Swannanoa River, North Fork, measurement of ... 128
Sweetwater Creek, measurement of ... 179

T.

Talking Rock Creek, measurement of ... 181
Tallapoosa River, measurements of ... 181
tributaries of, measurements of ... 181
Talona Creek, measurement of ... 181
Tate Creek, measurement of ... 179
Tellico River, measurements of ... 176, 177
Temperature, variation in ... 22-23
Tennessee River, features of ... 17-18
tributaries of, measurements of ... 176-177
Tessantee Creek, East Fork, measurements of ... 179
Thomas Creek, features of ... 57
measurement of ... 53
Three Fork Creek, measurement of ... 109
Threemile Creek, measurements of ... 108
Threetop Creek, measurements of ... 174
water powers of ... 174
Tickanetley River, measurement of ... 181
Tiger Creek, measurement of ... 178
Tiger River, measurement of ... 143
Toccoa River, measurements of ... 177, 178
Toe River, measurements of ... 108
Tombigbee River, measurement of ... 180
Topography, smoothly rounded, view showing ... 24
Town Creek (Hiwassee), measurement of ... 177
Town Creek (Watauga), features of ... 91
measurements of ... 86
Transportation, means of ... 47, 58, 83
See also Railroads.

Page.

Transylvania County, N. C., features of ... 116-117
Tuckasegee Falls, view of ... 176
Tuckasegee River, view of ... 176
water-power development on, view of ... 178
Tucker Creek, measurement of ... 128
Turkey Creek, features of ... 134
measurements of ... 128
Turkey Cove Creek, measurements of ... 151

U.

Unaka Mountains, features of ... 36-38
Upper Creek, features of ... 156-157
measurements of ... 151
Upper Laurel Creek, measurements of ... 86

V.

Valley Creek, measurement of ... 180
Valley of East Tennessee, features of ... 20, 38-39
Valley River Mountains, mean elevation of ... 13
Vegetation and soil, character and extent of ... 30-33

W.

Wahoo Creek, measurement of ... 179
Walker Creek, features of ... 75
measurements of ... 73
Walnut Creek, features of ... 132
measurements of ... 126
Watauga Lumber Company, forests of and lumbering by ... 27
Watauga River, drainage basin of ... 77-81
features of ... 18
measurements of ... 83-84
minerals in basin of ... 83
rainfall in basin of ... 81-82
springs in basin of ... 82
timber in basin of ... 82-83
transportation facilities in basin of ... 83
tributaries of, features of ... 87-95
tributaries of, measurements of ... 85-86
water powers of ... 84-85
Water resources, features of ... 17-20
Wateree River. *See* Catawba River.
Weaver Creek (Hiwassee), measurement of ... 178
Weaver Creek (South Fork Holston), features of ... 55
Wedstone Creek, features of ... 68
West Branch or Fork of any stream, *see* the stream.
Whitecak Creek (Broad), measurement of ... 143
Whiteoak creeks (Nolichucky), measurements of ... 109
Whites Creek, measurement of ... 179
Whiteside Mountain, features of ... 22
view of ... 24
Whitetop Creek (Laurel Fork Holston), features of ... 66-67
Whitetop Creek (South Fork Holston), measurements of ... 62
Widner Creek, features of ... 67

	Page.
Wildcat Creek, measurement of	181
Williams Creek, measurement of	177
Willieo Creek, measurements of	180
Wilson Creek (Catawba), measurement of	152
Wilson Creek (New), measurements of	170
Wilson Creek (Watauga), measurement of	85
Wind Creek, measurement of	181
Wolf Creek (French Broad), features of	129–130
Wolf Creek (Hiwassee), measurement of	177
Wolf Creek (South Fork Holston), features of	60–61
measurements of	53

Y.	Page.
Yadkin River, drainage basin of	158–160
features of	19
forests in basin of	161
measurements of	161
soils in basin of	160–161
tributaries of, features of	165–169
tributaries of, measurements of	164
water powers of	162–164
Yahoola Creek, measurements of	179
Yalabusha River, measurements of	180
Yellow Creek (Chattahoochee), measurement of	179
Yellow Creek (Etowah), measurement of	180
Yellow Mountain, elevation of	13
Yonahlossee road, view of	38
Young Cone Creek, measurement of	177

O