REPORT ON THE WATER-POWER

OF THE

SOUTHERN ATLANTIC WATER-SHED,

BY

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REPORT ON THE SOUTHERN ATLANTIC WATER-SHED.

PREFATORY LETTER.

BOSTON, MASS., *September 20, 1881.*

Prof. W. P. TROWBRIDGE,
Columbia College, New York City.

SIR: I have the honor to submit herewith my report on the water-power of the streams draining what I have designated as the "Southern Atlantic Water-shed", or, in other words, of the streams flowing into the Atlantic south of the James river. My report on the streams of the middle Atlantic water-shed, comprising the streams as far north as the Hudson, is in course of preparation, and will be duly submitted when completed. In making this division of the territory assigned me I have been guided by a desire to group together such streams as possess the greatest number of features in common, and it seemed as though the line had best be drawn at about the southern limit of the state of Virginia, which is often classed as one of the middle states.

Following the directions which I have from time to time received from you, I have traveled over most of the country covered by this report, and have collected as much information as was possible with the time at disposal. With so large a territory to traverse in so short a time, anything like thoroughness has, of course, been impossible, and my work must be considered a rough reconnoissance only. I have been able to visit in person only a few of the water-powers in my district, many of which are inaccessible; and, for information regarding even some of the important ones, I have been obliged to depend on hearsay or on correspondence. Even in the case of powers which I visited I am able, in many cases, to present only their general features, having been unable to spare the time necessary for a detailed examination. The only instrument of measurement used was a Locke pocket-level, with which I was enabled to arrive, in some cases, at quite close approximations to the fall, while in others the results obtained are liable to large error. Those who have used the instrument will testify to the fact that, when long sights have to be taken, the want of sensitiveness of the bubble renders accurate results impossible. In one case I was enabled to make use of an aneroid barometer, kindly loaned me for the occasion by Professor Kerr, the state geologist of North Carolina, but with this single exception the pocket-level was the only instrument of measurement used.

In preparing this report I have made use of all the material within my reach, giving due acknowledgment in each case where other reports or publications have been used extensively. To the reports of the Chief of Engineers, U. S. A., and those of the officers of the corps, I am indebted for so much information that it would be useless to attempt to refer to the authority for each statement taken from them, when it is not of particular importance. To the officers themselves, and their assistants, I am also personally indebted for valuable aid, advice, and information while at work in the field. My acknowledgments are also due in this place to the officers and engineers of the various railroads in the district, who have, with the greatest kindness and interest, furnished me with elevations of streams along their roads, and with general information concerning the country. To civil engineers, state officers, and private citizens, all through the district, I am indebted for the greatest encouragement in the prosecution of my work, and for information of all kinds. Particularly must I here acknowledge the obligations I am under to Prof. W. C. Kerr, state geologist of North Carolina, for copies of reports on geology and allied subjects bearing on water-power, and for aid and advice in very many cases. To him is due chiefly whatever success may be found to have attended my efforts to present an adequate view of the water-power of his state.

In discussing the material thus collected I have, after dividing my district into the two divisions above named, prefaced the descriptions of the various rivers by a general description of the districts so far as their common characteristics are concerned. In giving information regarding particular powers I have endeavored to let each statement pass for what it is worth, and for no more; and where inaccuracies are liable to occur, I have repeatedly called attention to them.

The drainage areas given in the report were measured geometrically, there being no planimeter in possession of the office at the time they were determined. I have, however, checked them in so many ways that I believe them to be accurate measurements of the areas as taken from the maps. The latter are, in many cases, so inaccurate that slight errors in measurement are of no importance. I have uniformly used Colton's largest maps of the separate states, which were the best I could find. In checking my measurements of the drainage-basins of the larger streams, by comparing them with those of Mr. Gannett, published in Census Bulletin No. 78, I have had the satisfaction of finding that the two agree, generally, within 1 or 2 per cent.

In making estimates of the amount of power available at the various sites I have endeavored to proceed according to the most approved methods in use in this country, and to pay proper attention to the most advanced and recent investigations in this direction. Having fully explained, in the introduction, the methods I have used, it is unnecessary for me to do more here than to call attention to this point. In view of the uncertainty attending all such estimates of power, in the absence of a series of gaugings of the streams in question, it may seem that I have gone too far in this direction; but it has appeared to me that it was essential to give some idea of the amount of power which could be fairly expected at each important site, in order that people might not be misled by too high estimates, which are the rule and not the exception.

Finally, regarding the arrangement of this report, it is to be remarked that, although a logical arrangement would probably have placed this report on the southern Atlantic water-shed after that on the middle Atlantic water-shed, various causes have combined to render it advisable to prepare and submit the present report first; among which may be mentioned the completeness of the data at hand, and the fact that I consider this report, on the whole, the more important of the two. It is hoped that this sacrifice of logical sequence will not involve any loss of clearness.

I am, sir, very respectfully, your obedient servant,

GEORGE F. SWAIN,
Special Agent.

THE SOUTHERN ATLANTIC WATER-SHED.

Having divided the territory covered by my examination into two districts, the middle and the southern Atlantic water-sheds (the boundary between the two being the ridge between the basins of the James river and the streams south), I proceed first to discuss the second of these districts.

The state of Florida will for the present be left out of consideration, partly because it possesses no water-power of importance, and partly because its peculiar situation renders its climate, in some respects, different from that of the other southern Atlantic states. The few remarks that are to be made regarding Florida will be found at the end of this report.

The general characteristics of the territory considered will first be given, and afterward a discussion of each stream separately.

GENERAL CHARACTERISTICS.

1.—Area and form.

The area to be considered comprises about 117,350 square miles, distributed, approximately, as follows among the different states:

	Square miles.
Virginia	10,350
North Carolina	45,000
South Carolina	31,000
Georgia	31,000
Total	117,350

This area is in the shape of a strip lying along the Atlantic ocean between the parallels of (nearly) $30\frac{1}{2}°$ and $36\frac{1}{2}°$ north latitude, and with an average breadth, at right angles to the coast, of about 240 miles, except in the extreme southern part, where it narrows down to about 60 miles. The general direction of the coast-line is northeast and southwest, turning quite abruptly to the north in North Carolina, and curving toward the south in Georgia.

2.—Geographical and continental position.

The district considered is therefore in the north temperate zone, and in the zone in which the prevailing winds are the return trades, which blow from the southwest. The winds are, however, not constant, but blow from all points of the compass, and the prevailing ones from different points, according to the season. I shall discuss the winds more fully under the head of "climate", and it will suffice to say here that, in consequence of the continental position of the region considered—extending almost to the Gulf of Mexico, and flanked on the west by the system of the Alleghanies—the winds from all points of the compass, from northeast, through east and south, to southwest, are, to a certain degree, oceanic, varying in different parts of the region, while the distinctly land-winds are those from the west, northwest, and north. This district is, in fact, directly in the line of the return trades, which blow from the Gulf of Mexico, carrying its vapors far inland, and far along the coast, even so far as Virginia, the influence of the Gulf being, as regards moisture and rain-fall, much more sensible than that of the Atlantic ocean as regards the region as a whole.

3.—Topography.

The district under consideration may be divided, topographically, into three distinct and well-defined divisions, viz, the lower or eastern, the middle, and the mountainous or western.

The *eastern division* extends from the coast inland for a distance varying between 100 and 140 miles, and including the navigable portions of the rivers. Its boundary inland is a line passing through Richmond and Petersburg, Virginia; Weldon, Rocky Mount, Smithfield, North Carolina; a little above Fayetteville, North Carolina, Cheraw and Camden, South Carolina; and through Columbia, South Carolina, and Augusta, Milledgeville, Macon, and Columbus, Georgia. This line plays a very important part in the topography, geology, and water-power of the country, and is nothing more than the continuation of the line which may be designated as the *fall-line*, and which extends through the middle states, passing through Fredericksburg and Georgetown. It may be traced beyond Columbus for some distance along the Gulf, passing through Wetumpka and Tuscaloosa, Alabama. In the northern part of this district tide-water extends up to the fall-line, as at Richmond and Petersburg, but in the southern part the line is a long distance above tide-water. In another place I shall refer to this line and the important water-powers connected with it. The country between it and the coast belongs, geologically, to the Tertiary and Post-tertiary formations, and "is for the most part nearly level or very gently undulating, except along the river courses, on the upper reaches of which rise bluffs and small hills".* It comprises nearly two-fifths of the area of North Carolina,† over one-half of that of South Carolina, and about two-thirds of that part of Georgia which we are considering. Its slope seaward in North Carolina is between one and two feet to the mile,* and is probably about the same in South Carolina and Georgia. Its average elevation above the sea is probably in the neighborhood of 150 or 175 feet, and the slope toward the sea is, on the whole, uniform.

The rivers in this division are sluggish and navigable streams, frequently tidal for 20 or 30 miles from their mouths, and flow in beds composed of sand and clay. They are often exceedingly tortuous, and the chief obstructions to navigation consist in shifting sand-bars, snags, and trees, which have been undermined and have fallen over into the stream. The banks are unstable, and although the rivers do not rise very high in freshets in this part of their course, they frequently undermine the banks, and even cut new channels for themselves, in consequence of their extreme tortuosity, although they are not so crooked as many of the western streams. We shall notice, farther on, the bearing of these facts on the availability or accessibility of the water-powers.

The river valleys in this division are characterized by having their longest slopes on the north side of the river, from which side also the principal tributaries enter—facts which have been clearly explained by Professor Kerr.

The *middle division*, or hill country, extends from the fall-line to the base of the mountains, with an average width of from about 100 or 120 miles in the south to 150 in the north. It includes nearly one-half of North Carolina, nearly one-half of South Carolina, and about one-third of that part of Georgia which we are considering. Its boundaries are, topographically, not very sharply defined, and it forms a term of transition from the sea-board plane to the mountains. Geologically, almost the entire region is metamorphic.

The average elevation above the sea of the streams at the fall-line is probably not far from 125 feet, varying from about 250 feet in the south to about 50 feet in the north. The following list of elevations of streams will show how the elevation varies between Richmond, Virginia, and Macon, Georgia. I am indebted for the figures to various railroad managers and engineers, and to other sources: ‡

River.	Place.	Elevation above mean tide.
		Feet.
James	Richmond, Va	†0.0
Appomattox	Petersburg, Va	†0.0
Roanoke	Weldon, N. C	44.0
Tar	Rocky Mount, N. C	....
Neuse	Smithfield, N. C	100.0
Cape Fear	Averysboro', N. C	85.0
Pee Dee	C. C. R. R. crossing	106.0
Wateree	10 miles above Camden	125.0
Congaree	Columbia, S. C	129.0
Savannah	Augusta, Ga	125.0
Ogeechee	Shoals of Ogeechee, 8½ miles below Mayfield, Ga	210.0
Oconee	Milledgeville, Ga	224.0
Ocmulgee	Macon, Ga	250.0

The average elevation of the ground along the fall-line is greater, probably averaging 200 feet, varying from 300 feet in Georgia to 100 feet in Virginia and northern North Carolina. The average elevation of the upper limit of the middle division may be taken at about 1,200 feet, and the average elevation of the whole district at about

* *Geology of North Carolina*, vol. i, W. C. KERR.

† Prof. KERR, *Geology of North Carolina*.

‡ This table is only a rough approximation. It was not possible to get accurate elevations on account of differences in the datum-planes used by the various railroad companies. For instance, Richmond and Petersburg are at the heads of tide-water; yet the rivers there are probably several feet above mean tide at Norfolk. In some cases the above figures have been obtained by estimating the fall above points whose elevations were given.

700 feet. Its average slope is, therefore, not less than 5 or 6 feet to the mile. The character of this division varies by insensible degrees from that of the flat eastern division to that of the mountainous western one. The eastern part is gently rolling, while the western is penetrated by numerous spurs of the mountains, forming divides between the great river-basins, and sometimes with elevations exceeding 3,000 feet.

The rivers in this region are tolerably rapid, and well suited for the development of water-power. They are not navigable, on account of the numerous shoals and ledges, though some of them might be made so. Almost all of the water-power now used is in this section.

The *western* or *mountainous division* comprises the Atlantic slope of the Blue Ridge, and occupies but a small part of the area under consideration. The general direction of the Blue Ridge is about NE., a little E., nearly parallel to the coast, and it is in North Carolina that the system to which it belongs attains its greatest altitude, some of the peaks attaining an elevation of over 6,000 feet, while some peaks in Georgia exceed 4,000 feet in height. Although the chain of the Blue Ridge is far from regular, either in direction or in elevation, contrasting strongly in these respects with the Smoky mountains, a second range lying west of it, yet the general structure of these mountains is the same as in the middle states; they consist of a series of ridges, and not, like the mountains of Maine, of a series of isolated cones.

The streams in this division are, of course, small and very rapid. Their fall is very great, and is interrupted in many cases by cascades and precipitous falls, sometimes of several hundred feet, nearly vertical. The bed is almost always rock, sometimes overlaid with a stratum of gravel, and the valleys narrow, in some places with very steep and even vertical banks—hundreds of feet high in a few very rare cases. These streams are subject to considerable fluctuations in volume, and the water-power, although great, is not very available.

There are no lakes in any part of the region under consideration except a few near the coast, a position which renders them of no value as regards water-power.

4.—Geology, soils, and forests.

As has been already stated, the entire eastern division of this district belongs to the Tertiary and Quaternary formations. Its soil is for the most part a sandy loam. Clay and sand, in fact, constitute the soil of almost the whole district; in the eastern part the sand predominates, while in the middle and western parts the clay predominates. There are also in the eastern part beds of gravel, marl, and peat, and there is generally a clay subsoil not far below the surface. In some places, too, there are beds of quite pure sand (the sand-hills), which give rise to several streams noticeable for their water-power, and there seems to be a belt of these sand-hills just below the fall-line, having a width of 30 to 40 miles in places.

In the middle and western parts of the region, besides the clay soil just referred to, and which is the predominant soil, there are also beds of gravel and sand. It is an important fact that the soil here is very deep—much deeper than in the middle states—and that it has resulted from the decay of the rocks *in situ*. The clay is generally red, less frequently yellow, and, being mixed to a considerable extent with sand and gravel, it is not impervious. When well compacted, however, it is said to make a good dam.

Almost all of the middle and western parts of this region are metamorphic. The general direction of the strike of the strata is NE. and SW., about parallel to the mountains, and the streams cross these strata generally at large angles, and thus form shoals, which afford abundance of fine water-power. The prevailing rocks are granite and gneiss, with their varieties. In upper South Carolina nearly all the water-powers are caused by the streams crossing the ledges of gneiss, and the same is true for the other states, though, perhaps, not to so great a degree. It is important to notice that the rocks are generally impervious.

On account of the important influence exercised by forests on water-power, it is an important fact that the greater part of the region we are considering is well wooded. The eastern part abounds in extensive forests of long-leaf pine, with large quantities of cypress and palmetto along the river-bottoms, but in the middle portion there is, unfortunately, no effort made to preserve the forests, and they are said to be disappearing rapidly. In the western part they are abundant, the mountains being heavily wooded. Some of the peaks, however, called *balds*, are, it is true, entirely destitute of trees on their summits, but in general the mountains are covered with heavy forests. It is important to notice, also, that the mountains, even the highest ranges and peaks, are covered with soil to a considerable depth.

As regards variety of woods, it is sufficient to mention the fact that the state of Georgia alone produces 230 different kinds of wood.*

* Dr. Little, in *Eclectic Geography*, Georgia edition.

According to the census of 1870 the number of square miles of land not in farms, added to that of woodland in farms, is as follows for the different states:

State.	Land area of state.	Area above described.	Per cent.
Virginia	40,125	24,733	61
North Carolina	48,580	36,379	75
South Carolina	30,170	21,324	71
Georgia	58,980	42,230	72
Maine	29,895	24,249	81
New Hampshire	9,005	5,007	56
Vermont	9,135	4,226	46
Massachusetts	8,040	4,878	61
Rhode Island	1,085	565	52
Connecticut	4,845	2,053	42
New York	47,620	21,822	46
New Jersey	7,455	3,906	52
Pennsylvania	44,985	25,839	57
Maryland	9,860	5,053	51

How much of the areas in the second column are woodlands I cannot say. It seems probable, however, that the southern states are better wooded than the New England and middle states, except Maine.

5.—CLIMATE.

The climate exercises such an important influence on the water-power of a district that it seems necessary to consider it in some detail. The following elements, which go to determine the climate of a place, will be considered: *a.* Length of coast and character of ocean-currents; *b.* prevailing winds at different seasons; *c.* temperature at different seasons; *d.* precipitation, amount in different seasons and distribution over the area considered; *e.* evaporation and moisture.

a. COAST-LINE AND OCEAN-CURRENTS.—The fact has been already referred to that the general direction of the coast-line is NE. and SW., and that the winds from NE. round to SW. are maritime. The total length of coast-line, not including indentations, is in the neighborhood of 580 miles. Along this coast, and a short distance from it, sweeps the Gulf Stream, keeping its course across the Atlantic from cape Hatteras, and leaving the upper part of North Carolina and the states north exposed in a greater degree to the cold current from the north, which flows along the New England coast. Hence, the winds from NE. are cool, while those from SE. are warm and moist. The effect of all these circumstances on water-power will be referred to again.

b. PREVAILING WINDS AT DIFFERENT SEASONS.—The winds in this district are variable. They blow from all quarters, the prevailing wind being different in different parts of the region, and at different seasons. On the whole, however, the prevailing winds are from the west, or some point between SW. and NW. But it is a very striking fact that the resultant wind, or the wind found by working out a traverse from observations of the frequency of the various winds throughout the year,* is almost invariably, in all parts of the region, from a point between SW. and NW., a fact which indicates that the general movement of the atmosphere is toward the east. On the immediate seaboard the winds from S. and SE. are frequent, and in the middle section northerly winds are, at least in North Carolina, very frequent, coming next in order to those from the west. As regards the distribution of the winds through the seasons, the winds from S., SE., and SW. are most prominent during the spring and summer, while in autumn and winter the winds from N., NE., and NW. are most frequent. Winds from the east are the least frequent of all.

As regards water-power, the most salient points to be noticed are that there is no distinct periodicity in the winds, and that the general movement of the atmosphere in summer and spring is from a point south of west, and in autumn and winter from a point north of west.

c. TEMPERATURE AT DIFFERENT SEASONS.—The mean temperatures for the year and for the seasons, as well as the extremes and the range, vary considerably in the three divisions of the region we are considering. In fact, the isothermal lines, instead of following the parallels of latitude (their normal course), are deflected toward the south by the mountains which bound the district on the west, and in the western division they run almost parallel to the coast, while in the middle and eastern divisions they run at an angle of some 45° with it. The following tables, consisting of observations selected from among those given in the *Smithsonian Contributions to Knowledge*, vol. 21, and in Professor Kerr's report on the geology of North Carolina, will give some idea of the temperature in different parts of the region, and at different seasons. The means for the different sections have been obtained by examining the temperature charts in the publications of the Smithsonian Institution.

* COFFIN: *The Winds of the Globe.*—Smithsonian Contrib., vol. 20.

Observations of temperature at different seasons.

Division.	Station.	Latitude.	Longitude.	Elevation.	Mean temperature (degrees Fahrenheit). Spring.	Summer.	Autumn.	Winter.	Year.	Length of time observed.
		° ′	° ′	Feet.						Yr. mo.
Eastern	Norfolk, Va	36 51	76 17	20	57	77	61	42	59	25 0
	Murfreesboro', N. C	36 26	77 01	75	58	76	59	43	59	4 0
	Weldon, N. C	36 23	77 45	72	57	78	56	40	58	3 0
	Poplar Branch, N. C	36 14	76 00	10	57	79	62	43	60	2 0
	Scotland Neck, N. C	36 07	77 32	50	56	75	57	41	57	2 0
	Goldsboro', N. C	35 21	78 02	102	61	80	62	45	62	4 0
	Wilmington, N. C	34 17	77 58	50	62	79	63	48	63	3 0
	Aiken, S. C	33 32	81 33	565	61	77	62	46	62	8 8
	Camden, S. C	34 15	80 31	240	62	79	62	45	62	9 9
	Charleston, S. C	32 47	79 56	20	65	80	67	51	66	44 8
	Fort Moultrie, S. C	32 45	79 51	25	66	81	68	52	67	32 11
	Perry, Ga	32 28	83 43	280	67	80	65	49	65	2 3
	Savannah, Ga	32 05	81 06	42	67	81	67	53	67	26 1
Middle	Lynchburg, Va	37 22	79 12	800	55	75	58	40	57	3 9
	Gaston, N. C	36 28	77 38	152	56	76	58	40	58	4 6
	Oxford, N. C	36 22	78 29	475	57	78	58	40	58	7 0
	Greensboro', N. C	36 05	79 50	843	60	78	62	41	60	3 0
	Chapel Hill, N. C	35 58	78 54	570	59	76	61	42	60	20 0
	Lenoir, N. C	35 57	81 34	1, 185	55	74	55	38	56	3 0
	Statesville, N. C	35 47	80 53	940	53	74	54	36	54	7 0
	Raleigh, N. C	35 47	78 41	350	58	78	60	40	59	4 0
	Charlotte, N. C	35 16	80 50	725	59	77	58	40	59	3 0
	Albemarle, N. C	35 18	80 11	650	56	77	57	40	58	4 0
	Abbeville, S. C	34 12	82 17	500	63	79	63	47	63	2 10
	Columbia, S. C	34 02	80 57	315	62	78	63	45	62	4 11
	Athens, Ga	33 58	83 25	850	61	76	61	46	61	6 6
	Atlanta, Ga	33 45	84 24	1, 050	58	75	58	42	58	5 2
	Penfield, Ga	33 38	83 09	724	60	79	61	45	61	2 7
	Augusta Arsenal, Ga	33 28	81 53	350	64	80	64	48	64	21 7
	Sparta, Ga	33 15	82 54	550	62	78	63	46	62	9 0
Western	Boone, N. C	36 14	81 39	3, 250	47	68	48	32	49	2 0
	Bakersville, N. C	36 03	82 06	2, 550	51	71	52	36	53	1 0
	Asheville, N. C	35 36	82 28	2, 250	53	72	54	38	54	6 6
	Murphy, N. C	35 06	83 29	1, 614	56	72	53	39	55	2 6
	Clarksville, Ga	34 40	83 31	1, 632	....	72	56	44	....	2 3
	Brunswick, Me	43 54	69 57	74	42	65	48	23	45	51 3
	Concord, N. H	43 12	71 29	374	44	68	49	23	46	22 2
	Boston, Mass	42 21	71 03	82	46	69	51	28	49	38 5
	Providence, R. I	41 50	71 24	155	45	68	51	27	48	34 8
	Hartford, Conn	41 46	72 41	60	48	70	52	30	50	16 6
	New Haven, Conn	41 18	72 57	45	47	70	51	28	49	86 0
	Albany, N. Y	42 39	73 44	130	47	70	50	25	48	45 11
	New York, N. Y	40 45	73 58	42	48	73	55	31	52	21 11
	Newark, N. J	40 44	74 10	35	48	70	53	31	51	24 5
	Reading, Pa	40 20	75 55	269	50	72	53	31	52	6 8
	Harrisburg, Pa	40 16	76 53	375	52	76	55	32	54	29 3
	Philadelphia, Pa	39 56	75 10	36	51	74	54	33	53	39 10
	Carlisle Barracks, Pa	40 12	77 11	600	50	73	52	30	51	29 5
	Fort Delaware, Del	39 25	75 34	10	52	75	58	34	55	18 10
	Baltimore, Md	39 17	76 37	80	52	73	55	34	54	18 9
	Washington, D. C	38 54	77 02	75	56	76	56	36	56	12 3
	Cincinnati, Ohio	39 06	84 30	540	54	75	55	34	55	36 8
	Chicago, Ill	41 54	87 38	600	44	67	48	25	46	17 3
	Peoria, Ill	40 43	89 30	512	51	74	53	27	51	14 9
	Fort Madison, Iowa	40 37	91 28	600	50	75	52	25	51	21 10
	Muscatine, Iowa	41 26	91 05	586	47	69	49	23	47	27 6
	Huntsville, Ala	34 45	86 40	600	60	76	60	42	60	13 0
	Mobile, Ala	30 41	88 02	15	67	79	66	52	66	10 0
		Deg.								
Eastern	North Carolina and Virginia	34.5 – 36.5	....	0 – 200	59	79	60	46	61	....
	South Carolina	32.5 – 34.5	....	0 – 300	62	79	63	48	63	....
	Georgia	31.0 – 33.0	....	0 – 350	67	80	64	50	65	....
	Total	31.0 – 36.5	....	....	62	79	63	48	63	....

Observations of temperature—Continued.

Division.	Station.	Latitude.	Longitude.	Elevation.	Mean temperature (degrees Fahrenheit). Spring.	Summer.	Autumn.	Winter.	Year.	Length of time observed.
		Deg.	*Deg.*	*Feet.*						*Yr. mo.*
Middle	North Carolina and Virginia	37.0 35.0		200 1,200	57.00	77.00	59.00	44.00	59.00	
	South Carolina	35.0 34.0		300 1,100	61.00	77.00	62.00	45.00	61.00	
	Georgia	34.5 32.5		350 1,100	60.00	77.00	61.00	44.00	60.00	
	Total	37.0 32.5			60.00	77.00	61.00	44.00	60.00	
Western	North Carolina and Virginia	37.0 35.0		1,200 6,000	52.00	70.00	52.00	36.00	52.00	
	South Carolina									
	Georgia	35.0 34.0		1,100 4,000	54.00	72.00	55.00	36.00	54.00	
	Total	37.0 34.0			53.00	71.00	54.00	36.00	53.00	
	New England	42.5 41.0			46.00	69.00	51.00	28.00	49.00	
	New England	44.0 42.5			43.00	67.00	49.00	23.00	45.00	
	Middle States	41.0 39.0			50.00	73.00	54.00	32.00	52.00	
	Western States	41.5 30.0	91.5 84.5		49.00	72.00	51.00	26.00	50.00	

For comparison, the results are tabulated for some places in other parts of the United States at the end of the table. The places named as belonging to the western division are really outside of it, on the other side of the Blue Ridge; but as no records of observations for places on this side of the ridge could be found, I have inserted these values, as giving an idea of the temperature in that region, which may be considered accurate enough. The averages for the three divisions, at the end of the table, as well as for the other parts of the country, are only approximations, but are close enough to give a general idea of the differences between the region we are considering and the other parts of the country.

These tables show that middle South Carolina is somewhat warmer than middle Georgia, and much warmer than middle North Carolina. The isothermals bend inward, or around South Carolina, receding further from the coast in that state than in North Carolina or Georgia.

The following table of extreme observed temperatures may be interesting:

State.	Maximum temperature observed.	Month.	Place of observation.	Minimum temperature observed.	Month.	Place of observation.
	Deg.			*Deg.*		
North Carolina	102	July	Fort Johnston	3	February	Fort Johnston.
South Carolina	101	July	Charleston	6	February	Fort Moultrie.
Georgia	103	July	Augusta arsenal	—2	February	Augusta arsenal.
Alabama	104	August	Mount Vernon arsenal	—9	January	Huntsville.
Maine	102	July	Brunswick	—32	January	Brunswick.
Massachusetts	100	July	Fort Warren	—30	January	Williamstown.
Virginia	104	August	Alexandria	2	January	Fort Monroe.

These figures, as well as all the others pertaining to temperature and rainfall, have been taken principally from the *Smithsonian Contributions*. Lorin Blodgett, in his *Climatology of the United States*, p. 150, gives figures somewhat different. Thus, he states that in the winter of 1834 and 1835, which was a winter of extreme cold in the south, the temperature at several places was as follows: On January 4, at Alexandria, Virginia, —16°; in February, at Richmond, —6°; Norfolk, +4°; Fayetteville, North Carolina, —1°; Greenville, South Carolina, —11°; Athens, Georgia, —10 1/2°; Clarksville, Georgia, —15°; Milledgeville, Georgia, —9°; Augusta, Georgia, —2°.

The following table gives the average temperature of the warmest day and the coldest day of the year, calculated, by Bessel's formula, from the recorded observations:

Place.	Latitude.	Longitude.	Elevation.	Temperature of warmest day.	Temperature of coldest day.	Range.	Number of years of observations.
	° ′	° ′	Feet.	Deg.	Deg.	Deg.	Yrs. mo.
Fort Brady, Mich	46 30	84 28	600	65.2	14.4	50.8	32 1
Brunswick, Me	43 54	69 57	74	67.9	19.5	48.4	51 3
New Bedford, Mass	41 39	70 56	90	70.2	27.1	43.1	58 1
New Haven, Conn	41 18	72 57	45	72.4	25.7	46.7	86 0
Baltimore, Md	39 16	76 35	36	77.0	32.0	45.0	36 0
Cincinnati, Ohio	39 06	84 30	540	77.9	32.3	45.6	36 8
St. Louis, Mo	38 37	90 12	481	78.5	30.3	48.2	41 0
Chapel Hill, N. C	35 58	78 54	570	78.9	40.9	38.0	29 0
Fort Moultrie, S. C	32 45	79 51	25	82.2	50.1	32.1	32 11
Fort Barrancas, Pensacola, Fla	30 21	87 18	20	82.6	52.9	29.7	20 2

d. RAINFALL.—The best idea of the rainfall in this region, as well as over the whole country, and of its distribution through the four seasons, can be obtained by consulting the charts originally published in No. 353 of the *Smithsonian Contributions to Knowledge*, where the whole subject is exhaustively discussed. According to the plan there adopted, of dividing the United States into a number of districts characterized by a general uniformity in the distribution of the rainfall, we have to devote our attention here to the district there referred to under type viii. Its characteristics are given as follows: "The principal maximum late in July, or early in August, with two small adjacent minima, about the middle of April and late in October. The subordinate maxima occur in March and December. Range very large." The observations from which this type curve is constructed are from five stations, all on the coast. The curve shows that the monthly rainfall fluctuates between 0.52 of the mean monthly rainfall (in April) and 1.92 of that mean (in August). Hence the average fluctuation is 140 per cent. of the mean monthly rainfall, or, in other words, in the month of maximum rainfall the fall is 3.7 times as much as it is in the month of minimum rainfall. For convenience of reference the ratios of fluctuation in the other characteristic districts are copied here:

		Per cent. of mean monthly rainfall.	Range.
I.	Atlantic coast, Portland to Washington	0.84 to 1.22	38
II.	Hudson river valley	0.69 to 1.29	60
III.	Upper Mississippi river	0.51 to 1.56	105
IV.	Ohio river valley	0.74 to 1.40	66
V.	Indian territory and western Arkansas	0.61 to 1.51	90
VI.	Lower Mississippi and Red rivers	0.75 to 1.19	44
VII.	Mississippi delta and Gulf coast	0.68 to 1.37	69
VIII.	Atlantic coast, Virginia to Florida	0.52 to 1.92	140
IX.	Western coast, San Francisco to Puget sound	0.13 to 2.45	232

As already stated, the ratios for type VIII were deduced from five stations, all on the immediate seaboard. The points regarding which the distribution of the rainfall farther inland differs from that on the coast will be noticed shortly. This ratio varies, however, within the district considered, and to a considerable degree in different latitudes. The following table, from which the ratio for this region was derived, will prove of interest:

Month.	Fort Monroe, Va., 19 years.	Charleston, S. C., 42 years.	Fort Moultrie, S. C., 17 years.	Savannah, Ga., 23 years.	Fort Brooke, Fla., 17 years.	Mean.
January	0.86	0.65	0.68	0.72	0.51	0.68
February	0.70	0.73	0.66	0.63	0.66	0.68
March	0.85	0.90	1.10	0.92	0.72	0.90
April	0.76	0.48	0 46	0.50	0.38	0.52
May	0.99	0.95	1.01	1.22	0.68	0.97
June	1.10	1.16	1.14	1.13	1.53	1.21
July	1.36	1.63	1.69	1.91	2.60	1.84
August	1.44	1.93	2.02	2.07	2.14	1.92
September	1.19	1.42	1.29	1.15	1.24	1.26
October	0.74	0.79	0.56	0.56	0.49	0.63
November	0.84	0.55	0.56	0.44	0.43	0.56
December	1.17	0.81	0.83	0.74	0.61	0.83

For more complete tables the original article may be referred to. The fluctuation evidently increases as we go south, and it may be assumed with sufficient accuracy, as follows:

	Per cent.
Latitude, 34°–37°; fluctuation	75
Latitude, 32°–34°; fluctuation	145
Latitude, 30°–32°; fluctuation	200

As regards the fluctuation of the *annual* rainfall the region considered does not differ much from New England and the middle states, as the following table will show:

Table of fluctuation of annual rainfall (fluctuation in per cent. of mean annual fall).

Place.	Limits of fluctuation.	Per cent.	Number of years observed.
Brunswick, Me	150–59	91	32
Hanover, N. H	139–79	60	19
Burlington, Vt	145–74	71	27
Boston, Mass	150–67	83	41
New Bedford, Mass	140–74	66	54
Providence, R. I	130–74	56	36
New Haven, Conn	126–76	50	23
Flatbush, N. Y	135–74	61	32
Philadelphia, Pa	143–67	76	43
Washington, D. C	143–62	81	30
Fort Monroe, Va	158–57	101	19
Charleston, S. C	151–54	97	42
Fort Moultrie, S. C	144–79	65	17
Saint John's, S. C	133–58	75	14
Savannah, Ga	145–54	91	23
Fort Brooke, Fla	168–67	101	15
Marietta, Ohio	145–76	69	48
Saint Louis, Mo	163–64	99	31
I. Atlantic coast, Maine to Virginia	123–73	50	63
II. New York and adjacent parts of Canada, New Hampshire, Massachusetts, and Vermont	122–76	46	41
III. Parts of Iowa, Minnesota, Illinois, and Wisconsin*	125–75	50	40
IV. Ohio valley, Ohio, Indiana, Illinois, Kentucky, and part of Missouri	126–71	55	49
V. Indian Territory and Arkansas*	146–62	84	23
VI. Louisiana, Alabama, and West Florida*	140–72	68	36
VII. Atlantic coast, Virginia to Florida*	136–78	58	24

*Only to be considered rough approximations, on account of small number of stations.

The most important fact connected with the rainfall is, however, that its distribution in the mountains and in the water-power district is by far not so variable as on the coast, a fact of the greatest significance as regards the flow of the streams and the amount of power available. I shall, further on, discuss the influence on the flow of the streams which is exerted by the various facts relating to this region, so that at present it is only necessary to mention the fact that, in the case of many of the streams in this part of the country, the rainfall on their water-shed above the fall-line is almost the same in winter as in summer, and even in some cases larger in winter. A glance at the Smithsonian maps will convince one of this fact, and also of the fact that the distribution is irregular, so that there is no gradual change in the law governing it, as we proceed from south to north.

As regards the absolute amount of rain the charts give the best idea, and to them I would refer. The average amount varies according to the latitude and the distance from the coast. The following brief tables will show to what extent:

Table of average rainfall (inches).

	North Carolina and Virginia.			South Carolina.			Georgia.		
	East.	Middle.	West.	East.	Middle.	West.	East.	Middle.	West.
Year	50	40–44	44–50	44	44–50	56	44	44	46
Summer	14	10–14	14–16	14	10–14	14–16	14	10–14	14–16
Winter	10–12	10–16	14	10–12	14–16	16	10	12–16	16

Rainfall table.

Place.	Latitude.	Longitude.	Elevation.	Spring.	Summer.	Autumn.	Winter.	Year.	Number of years observed.
	° ′	° ′	*Feet.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Yrs. mo.*
Gaston, N. C.	36 28	77 38	152	12.12	11.88	9.06	10.34	43.40	4 8
Chapel Hill, N. C	35 58	78 54	570	10.50	10.29	10.68	11.24	42.71	8 11
Fort Moultrie, S. C	32 45	79 51	25	9.75	18.37	9.15	8.24	45.51	17 1
Charleston, S. C	32 47	79 56	20	8.85	17.49	10.20	8.28	44.82	45 5
Camden, S. C	34 15	80 31	240	12.10	18.17	9.10	11.12	50.49	8 6
Saint John's, S. C	33 18	79 56	50	8.84	17.38	8.92	8.33	43.47	13 2
Waccamaw, S. C	33 29	79 17	20	8.28	14.88	10.08	9.96	43.20	9 4
Abbeville, S. C	34 13	82 28	500	13.53	12.11	6.65	17.06	49.35	2 10
Aiken, S. C	33 32	81 34	563	10.78	16.51	8.08	11.88	47.25	12 11
Sparta, Ga	33 17.	83 09	550	11.42	14.61	10.22	17.63	53.88	9 0
Savannah, Ga	32 05	81 05	42	10.39	20.81	8.61	8.86	48.67	30 10
Athens, Ga	33 57	83 30	860	10.82	13.17	7.11	12.09	43.19	7 5
Augusta, Ga	33 28	81 53	350	13.19	11.92	8.78	12.89	46.78	11 0
Brunswick, Me	43 54	69 57	74	11.70	11.71	11.42	9.84	44.67	32 1
Southern Maine	....	....	....	9 to 12	10	10 to 14	10 to 12	44 to 50	....
Northern Maine	....	....	....	6 to 9	10 to 12	10 to 12	8 to 10	38 to 40	....
New Hampshire	....	....	....	9 to 12	10 to 14	10 to 14	8 to 10	38 to 44	....
Hanover, N. H	43 42	72 17	530	9.91	11.9	10.58	9.08	40.66	19 0
Massachusetts to New Jersey	....	....	....	12	10 to 14	10 to 14	10 to 12	44 to 50	....
Western New York	....	....	....	6 to 9	6 to 10	8 to 10	6 to 8	28 to 32	....
Cincinnati, Ohio	39 06	84 28	480	11.17	12.67	9.29	9.83	42.96	41 11
Detroit, Mich	42 20	83 00	580	8.51	10.10	8.44	5.79	32.84	30 5
Saint Louis, Mo	38 37	90 16	481	11.71	13.01	8.58	7.39	40.69	40 0

The records are quite incomplete regarding this part of the country, most of the stations at which long records have been kept being on the immediate seaboard. On account of the lowness of the land near the coast and its swampy character the rainfall will increase for a certain distance inland, and will probably reach its maximum between the coast and the fall-line, diminishing from that line inland, but reaching a second maximum in the mountains. Professor Kerr, in his report of the Geological Survey, gives the rainfall in the different sections of North Carolina as follows:

	Inches.
Eastern division	58.1
Middle division	45.6
Western division	58.2
State	53.1

The observations from which these figures were deduced were made principally between the years 1871 and 1875, and from records furnished by Professor Baird it is evident that those years were years of large rainfall all along the southern Atlantic coast, the rainfall being, on the whole, considerably greater than the average at stations where long records exist. Professor Kerr thinks 45 inches too low a figure for North Carolina, and considers 53 inches more nearly correct. It seems to me, however, that the average rainfall for North Carolina should not be so much greater than for Charleston, South Carolina, or Savannah, Georgia. The preceding table, taken from the *Smithsonian Contributions*, shows the results of observation at these places, as well as at others. It will be seen that there are very few places where the annual rainfall amounts to 53 inches, and it seems to me that 45 to 50 inches is not too low a figure for North Carolina, according to all the information that I can at present gather. I have estimated from the Smithsonian charts the amount of rainfall for each river-basin, and the results are given in considering the rivers separately. I have endeavored to make the estimate too low rather than too high, so as not to overestimate the powers.

Snow.—Snow falls in all parts of the region under consideration. The average for three years at five stations in North Carolina gave a mean depth of 6 inches for the state.* In Georgia snow is rare, and seldom impedes communication, although it has been known to fall at several places to a depth of 3 feet.†

Fogs are very rare in all the district considered.

As regards *cloudiness*, Loomis gives the average cloudiness for the New England states as 0.53, and for the southern states as 0.47.‡

Freshets.—All the rivers in this region are subject to quite heavy freshets, not differing much, however, so far as I can learn, from those in the northern states, except as regards cause and times of occurrence. As there is little snow, there are no freshets to correspond with the ice-freshets at the north on the breaking up of the rivers, and

* Professor Kerr's report.

† Blodgett's *Climatology*, p. 147.

‡ *Meteorology*, p. 103.

thus one of the destructive elements of the freshets is removed. The freshets are irregular in the times of their occurrence, their duration, and the heights to which the water rises, so that any further remarks concerning them will be postponed until each river is considered by itself.

e. Evaporation and moisture.—The evaporative power of the atmosphere being determined by its temperature and its hygrometric state, a few remarks regarding the latter seem to be called for, the temperature having already been considered. I have, however, been unable to find much information regarding the moisture in the air at different places, but have noticed the fact that the relative humidity of the air seems to diminish as we proceed from south to north in the district under consideration. Professor Kerr, in his report on the geology of North Carolina, gives the results of hygrometric observations at Wilmington and Charlotte, and Blodgett, in his *Climatology*, has given some figures for New Orleans and Saint Louis. It appears from them that the average relative humidity for the year is as follows at these places: Wilmington, 57 per cent.; Charlotte, 65 per cent.; New Orleans, 86 per cent.; Saint Louis, 67 per cent.; London, 80 per cent.

The daily records of the observations in North Carolina show that at no time in the months of June, August, and October (the only ones for which the results are given) does the relative humidity exceed 97 per cent. Only once did it reach 97 per cent., once 95 per cent., and twice 90 per cent. Observations in Atlanta, for eleven months in 1876, give the average relative humidity at about 60 per cent., and show that in nine months of the year the maximum was 100 per cent., and in no month less than 93 per cent. The observations are not extended enough to serve as a basis for any general conclusions, but it seems evident that the moist winds from the Gulf deposit a large proportion of their moisture in the first few miles of their course, and after that deposit less and less, and become drier and drier, thereby increasing the evaporation as we proceed north. Other things being equal, and especially the distribution of the rainfall throughout the year, the southern streams would discharge a smaller proportion of the rainfall in their drainage-basins than the northern ones in the district considered. But the distribution of the rainfall is not the same, so that this conclusion cannot be drawn at once.

Before proceeding to discuss the effects exerted by the facts which have been stated on the water-power of the district under discussion it is desirable to show what the essential elements of a water-power are, and how they may be varied by the various climatic and other influences.

FLOW OF STREAMS.

The essential elements of a water-power are the fall and the quantity of water; and the amount of fall being a fixed quantity, capable of being measured once for all, and therefore not needing discussion, it is necessary to determine the amount of water that a given stream will afford at a certain point and the variation in the flow from month to month.

The average amount of water carried past a certain point in a year depends upon the amount and distribution of rainfall, the area of the drainage-basin, and the character of that basin. All the water carried by is derived from the rainfall, but of the total rainfall a certain amount is lost in the following ways: by percolation and discharge through subterranean channels; by evaporation from the soil and the surfaces of streams; by absorption through the roots of trees, shrubs, and grasses, and subsequent evaporation. The amount discharged by the streams will be greater as these sources of loss are diminished, and the problem before us is to determine for each particular case what proportion of the rainfall is so discharged; and we must, moreover, endeavor to find out the laws regulating the distribution of the flow through the year, and from year to year. In the case of most streams the flow varies greatly from day to day, and from month to month, being occasionally in times of freshet 50, 100, and even several hundred times its minimum volume. Thus the table given further on shows that the Potomac river at Cumberland has been known to discharge a quantity 716 times as great as its minimum discharge, while the maximum discharge of the Merrimac is only 44 times its minimum discharge. A great fluctuation in flow is evidently an obstacle to the extensive use of water-power, making it necessary to depend only on the flow at times when the stream is low, or to use auxiliary steam-power, or to store the freshet water in reservoirs, and so increase the flow in dry seasons. It is necessary, therefore, to discuss, to some extent, the total amount discharged by streams (or the proportion of the rainfall flowing off), and the manner in which that total amount is distributed through the year. As regards the first of these questions, it has generally been customary to assume a certain fixed proportion of the annual rainfall as flowing from the surface and discharged by the streams; but it has always been recognized that the proportion to be thus assumed varies greatly according to numerous circumstances, such as the area and form of the drainage-basin; the distribution of the rainfall through the year, as well as its amount; the extent of the forests; the number and extent of lakes; the character of the soil and rocks, and the state of cultivation; and all of these factors affect not only the total discharge of a stream, but also its distribution. With a given water-shed, in any particular year, a certain proportion of the rainfall will be discharged and distributed in a certain way, but both that proportion and that distribution are liable to change if any one of the above conditions are altered. Thus the greater the area of the water-shed the more uniform the flow, other things equal, because streams draining small areas are more subject to the effects of sudden rains than those draining large ones; and while in the former case there may be weeks at a time when no rain falls on the basin, and the stream draining it almost dries up, in the latter case there will probably be frequent rains on some part or other of the basin. The table given further on illustrates this point by showing that, as a rule, the ratio of maximum to minimum discharge is greater in the case of small streams than in that of large ones. And, in like manner, the form of the drainage-basin exerts a certain influence. The distribution of the rainfall is a very important point, and as an example of the great variability of the proportion of the rainfall discharged from the same water-shed in different years the case of the drainage area of the Albany water-works may be cited, where from an area of 2,600 acres in 1850, between May and October, inclusive, 41½ per cent. of the rainfall was carried off by the streams, while in 1851, within the same period (from May to October), 82.6 per cent. was discharged.* Hence it is that the year of minimum rainfall may not be the year in which the streams get lowest, or the one in which the season of absolute minimum flow occurs. An eminent authority has remarked: "This (the year with the season of least flow) is not necessarily the year of least rainfall, nor even the year of greatest apparent drought, but is the result of such a distribution of the rainfall that the excess of water over the amount needed for sustaining vegetation and supplying losses by evaporation is very small for several successive months."† The proportion of the rainfall discharged by streams is therefore a very uncertain and variable quantity, varying not only for different streams, but for the same stream in different years; and it is evident that the attempt to deduce the distribution of the flow of streams by taking certain proportions based on the rainfall is still more uncertain. Hence it is that some eminent engineers have given up the use of any proportion at all in calculations regarding the capacity of streams to furnish water-supply, and have adopted for this climate a certain fixed number of inches of rainfall as available. Mr. Croes has remarked in another place‡ that "the few records that exist of the flow from known drainage areas establish the fact that not over 15 inches per annum can be depended upon on the Atlantic slope, and many engineers who have devoted a good deal of attention to the subject are very decided in their opinion that not more than 11 inches should in any case be calculated on". The following table is copied from the same source:

Small annual yield of streams.

Stream.	Drainage area.	Year.	Rain.	Discharge.
	Sq. miles.		*Inches.*	*Inches.*
Eaton brook, N. Y	9.4	1835–'36	35.68	16.67
Patroon's creek, N. Y	12.5	1851	36.75	17.53
Cochituate, Mass	19.0	1870–'71	42.96	12.62
West branch of Croton, N. Y	20.0	1870–'71	39.36	18.88
Croton, N. Y	339.0	1864	40.80	14.89
Croton, N. Y	339.0	1872	40.74	19.00
Connecticut, Conn	10234.0	1877	....	21.71

In order to utilize all the discharge given in the last column a certain amount of storage room will be required, owing to the variation of the flow in different months.

It may not be out of place to devote a few lines here to a closer consideration of the causes affecting the fluctuations in the flow of streams. Evaporation, the principal source of loss, acts in different months with very different degrees of intensity, being generally greatest in the summer months and least in the winter. It is sometimes the custom, in calculating the amount of water-supply available for the use of a town, to assume a certain proportion of the rainfall of each month as collectible or as discharged through the streams, that proportion varying from 20 or 30 per cent. in summer months to 70 or 80 per cent., or even over 100 per cent., in others. Now, if we assume that the rainfall at any particular time reaches the streams within a short time after it has fallen, say within a month or so, then, if the rainfall is uniformly distributed throughout the year, the flow of the streams will decrease as the evaporation increases, and will be several times greater in some month (the month of maximum flow) than in some other month (the month of minimum flow). If, now, the rainfall be so distributed that in the months when the evaporation is *least* the greatest rainfall occurs, it is evident that the proportion of the rainfall discharged will be greater than in the first case, while the variability of the flow will also be greater. In this case, then, a larger amount of water will be available, but the storage necessary will also be larger, while the minimum and low-season flow of the stream, without storage, will be less than before.

Again, if the rainfall be so distributed that the greatest rainfall occurs in those months in which the evaporation is greatest, the proportion of the rainfall discharged by the streams will be less than in the first case, but the flow will be more uniform. In this case, then, a smaller amount of water will be available, but the necessary storage will be less, while the minimum flow of the stream, without storage, will be greater than in either of the previous cases. Hence we see how the distribution of the rainfall and the amount of the evaporation affect the flow of the streams,

*Hughes, *Waterworks*, p. 332.

†Newark Aqueduct Board, Report on Additional Water Supply, by J. J. R. Croes and G. W. Howell, 1879.

‡*Engineering News*, March 20, 1880, p. 104.

and by considering these, as well as the other elements affecting water-power, we may be able to judge of the relative value of two streams, and to form some estimate of their flow, even if no gaugings are at hand, although such estimates are very rough and liable to be greatly in error.

Two elements of a good water-power are, large flow, or large proportion of rainfall available, and uniform flow. The flow may be large, but if it is very variable the storage-room necessary to utilize it all may be too large, while a small flow, if uniform, could be utilized without any storage at all (except where it is desired to concentrate the power into less than twenty-four hours). But the remaining factors above named affect very materially the flow of streams, both in amount and in constancy, viz, soil, forests, lakes. The effect of these is felt in so many ways that it would not be the place here to discuss them extensively. But, as showing what principles have guided me in making my estimates of the flow of the various streams, I may be permitted to sum up here briefly these effects. A deep and porous soil, if underlaid by an impervious stratum, down to which the streams have cut their beds, has the effect of diminishing the evaporation and rendering the flow of the streams more constant. In some cases, however, and especially when the streams have not cut down to an impervious bed (that sheds the water that percolates to it), a deep and pervious soil is accompanied by considerable loss by flowage in subterranean courses, so that the flow of the streams may be diminished. It does not seem as though this were the case in the southern states. The action of lakes in regulating flow is evident, but it is next to impossible to estimate it numerically. They exert a more important influence in this respect than any other factor entering into the question. As regards forests, I am constrained to speak of their action somewhat at length because of the fact that, on account of the climatic conditions in some parts of the district under consideration, their influence may be overestimated. Although authorities are not agreed as to whether forests increase the actual amount of rainfall, the weight of evidence seems to be tending to prove that they do not. All are agreed, however, that they act as great regulators of the flow of streams. According to the results of the experiments at the Bavarian experiment stations the action of forests is as follows:*

1. They decrease the temperature of the ground, but in winter the effect is inappreciable.
2. They decrease the temperature of the air during the daytime, but in winter to an inappreciable extent, and increase it during the night in winter much more than in summer.
3. They have no influence on the absolute humidity of the air, but they increase greatly its *relative* humidity, and to a large extent at all seasons, but greater in summer than in winter.
4. They decrease evaporation from a free water-surface, and to an almost equal extent at all seasons, and also the evaporation from moist earth.
5. Trees themselves evaporate so much that the total evaporation from woods is greater than from open ground.
6. They decrease the amount of rainfall which reaches the ground by intercepting part of it by their leaves and branches.
7. They exert no influence on the distribution of rainfall throughout the year.
8. They have but a small effect, if any, in increasing the rainfall, but that effect is much greater in summer than in winter, and increases with the elevation above the sea.
9. They have no appreciable effect in increasing the total quantity of water penetrating the ground, but in winter they *decrease* that quantity, while in summer they increase it very considerably. The forests, therefore, diminish the quantity of water flowing directly from the surface in summer, and by storing it up, to be given out gradually, contribute to the constancy of the streams. (See page 20 for further remarks.)

I will now proceed to explain the general method I have followed in estimating the flow of the streams in this district. In calculating the amount of water-power available I have considered the flow of streams chiefly with reference to four quantities, viz:

1. The absolute minimum flow.
2. The minimum low-season flow.
3. The maximum flow available with storage.
4. The low-season flow in ordinarily dry years, but not the driest.

a. The absolute minimum flow determines the maximum power which the stream will afford, at a given point, *at all times;* but as this minimum flow generally occurs during a period of not over a few days at intervals of several years, it is not of so much importance as the other quantities, and if only this flow is utilized there will be a large amount of water wasting, even in the low season, for years in succession. The amount of this flow is best approximated to, probably, by assuming a certain discharge per square mile of water-shed, varying with the area of the water-shed and the local and climatic conditions. In estimating this flow I have made use of the results given in the table on page 20.

b. The minimum low-season flow is the smallest average amount flowing during a period of from six to three weeks, *generally* in summer, when the stream is at its lowest. In most years, the average flow during the season of least flow exceeds this amount. It may therefore be depended upon at all times, except for intervals of a day

* EBERMAYER: *Die physikalischen Einwirkungen des Waldes auf Luft und Boden, und seine klimatologische und hygienische Bedeutung.* Berlin, 1873.

or two, perhaps several days at a time, during which the flow approaches its absolute minimum, and may be rendered available at all times by a small amount of storage. In ordinary years there will be an excess almost all the time.

This minimum summer flow can probably be best estimated by comparison with experimental results, some of which are given in the table on page 21. But in most cases I have estimated it as follows:

1. Seven-tenths of the mean annual rainfall may, in general, be considered the minimum rainfall.

2. Forty per cent. of this may, on the average, for tolerably large drainage basins, be considered to be discharged by the streams, subject to variation, however, according to local and climatic conditions; but in no case should the amount determined in this way as the total amount discharged in a year exceed say 10 to 13 inches. If it does, not over 10 to 13 inches should be assumed. The storage necessary to render this flow available at all times I am unable to calculate with the data at hand.

3. The distribution of this flow through the year may be estimated from the results of the table on page 21, bearing in mind, however, in estimating the coefficient which expresses the proportion of the mean monthly rainfall which is discharged in the driest month, the various remarks concerning the district considered, on pages 22 to 24.

c. By increasing the storage-room a larger flow may be rendered available. In regard to the amount of increase possible, I have assumed that 10 to 13 inches is all that can be depended on permanently. Perhaps 11 to 13 inches may be assumed for New England and the middle states. In the region we are considering, according to the remarks on pages 16 to 18, I have modified these figures by taking them somewhat smaller, on the supposition that the percentage of rainfall discharged is smaller. This will agree pretty closely with the available annual flow in very dry years; for if we take 40 per cent. of the rainfall as available, and 0.7 of the mean annual rainfall for the rainfall during a dry year,* we shall have for a rainfall of 40 and 50 inches, respectively, 11.2 and 14 inches available.

Any calculations respecting the amount of storage necessary can only be rough approximations, and may, perhaps, prove entirely fallacious, on account of the total absence of data regarding the flow of the streams in different months. A comparison and a study of all the data that I can find regarding other streams has led me to the opinion that the storage necessary to render the above quantity available will be between 2 and 4 inches on the water-shed, varying according to the various local and climatic conditions (see pages 8 to 16) and according to the area of the water-shed, being greater for small water-sheds than for large ones. But this is a very rough approximation.

d. The mean low-season flow in dry years (but not the driest) I have approximated by taking 11 to 16 inches of rainfall available, and taking a certain proportion of this as the amount flowing in the one or two months of the season of low flow, according to the table on page 21, modified somewhat according to circumstances; or, in many cases, by simply increasing by one-seventh the estimate of the minimum low-season flow. Without storage, this flow may generally be depended upon, except in low seasons of very dry years, when the supply may be deficient for several weeks at a time. *In ordinary years one-quarter more may be calculated upon.*

In all cases referring to low-season flow the flow will generally be at least twice as great for nine months in the year.

Any attempt to utilize the mean annual flow would result in failure of supply in very dry years.

It is a question to be determined in each case separately, from financial and other considerations, how much power it will be desirable to utilize, with due consideration of such points as the length of time during which the supply will fail and cost of supplementary steam-power.

In view of the uncertainty of this subject, the estimates which I have made must all be considered only rough approximations, but on account of lack of data I am unable to make them more reliable.

* FANNING: *Treatise on American Water-Supply Engineering.*

The following tables have already been referred to, and are compiled from various sources:

Table showing extremes of flow for some American streams.

River.	Place.	Drainage area, square miles.	Mean rainfall, inches. Spring.	Summer.	Autumn.	Winter.	Year.	Length flowed, miles.	Remarks on character of drainage basin.	Extremes of flow. Maximum, cubic feet per second.	Minimum, cubic feet per second.	Ratio.	Minimum, cubic feet per second per square mile.	Ordinary low-water flow, cubic feet per second per square mile.	Authority and remarks.
Merrimack ..	....	3,598.00	10	11	13	9	43	....	Lakes and artificial reservoirs. Wooded.	....	1,638.00	....	0.414	....	J. B. Francis, quoted by J. P. Kirkwood.
Merrimack ..	Lawrence.........	4,136.00	10	11	13	9	43	....	Lakes and artificial reservoirs. Wooded.	96,782	2,192.00	44	0.530	....	C. Herschel.
Concord	Lowell...........	352.00	11	11	12	10	44	....	....	4,449	59.84	74	0.170	....	C. Herschel.
Sudbury	Framingham......	78.00	11	11	12	10	44	....	Hilly and swampy. One-sixth to one-eighth wooded.	3,228	2.80	1,153	0.036	....	A. Fteley.
Charles	....	236.00	11	11	12	10	44	....	Hilly and rolling	....	44.00	....	0.188	....	J. P. Kirkwood.
Hale's Brook, Mass.	....	24.00	11	11	12	10	44	....	....	....	3.24	....	0.135	....	J. P. Frizell.
Connecticut .	Hartford..........	10,234.00	10	12	12	10	44	....	Numerous lakes and artificial reservoirs. Wooded. Mountainous in parts.	207,443	5,219.00	40	0.510	....	T. G. Ellis.
Connecticut .	Dartmouth	3,287.00	10	12	12	10	44	....	Numerous lakes and artificial reservoirs. Wooded. Mountainous in parts.	....	1,006.00	....	0.306	....	C. Herschel.
Housatonic ..	....	790.00	12	12	12	10	46	....	....	....	130.00	....	0.165	....	H. Loomis, Rept. N. Y. Com. Pub. Wks., 1879.
Croton	....	338.82	12	13	13	10	48	....	....	25,367	50.80	500	0.150	....	J. J. R. Croes and G. W. Howell.
W. Br. Croton	....	20.37	12	13	13	10	48	....	....	1,109	0.407	2,722	0.020	....	J. J. R. Croes.
Passaic	....	855.00	12	14	12	10	48	....	Some lakes and swamps. Hilly.	....	178.00	....	0.208	....	J. J. R. Croes and G. W. Howell.
Passaic	....	981.00	12	14	12	10	48	....	Some lakes and swamps. Hilly.	19,944	225.60	88	0.230	....	J. J. R. Croes and G. W. Howell.
Delaware	Lambertville	6,500.0±	11	13	11	9	44	....	Hilly and rolling. Many lakes. Well wooded.	350,000	2,000.00	175	0.300	....	Ashbel Welch.
Schuylkill ...	Philadelphia......	1,800.00	12	14	10	9	45	....	Hilly and rolling. No lakes. Some reservoirs.	....	307.0 to 378.0	....	0.17 to 0.21	....	E. F. Smith and H. P. M. Birkinbine.
Hackensack .	....	84.00	12	14	12	10	48	....	Flat. No lakes or reservoirs, except mill-ponds.	....	27.00	....	0.33(?)	....	C. D. Ward.
Ohio	Pittsburg	19,900.00	10	12	9	10	41	....	Hilly and mountainous. No lakes. Wooded.	....	2,271.00	....	0.114	....	J. H. Harlow.
Potomac.....	Cumberland	920.00	10	12	9	8	39	65	Narrow valleys. Steep slopes. Wooded. No lakes.	17,900	25.00	716	0.022	....	W. R. Hutton and Patterson.
Potomac.....	Dam No. 5	4,640.0±	11	12	9	8	40	153	Narrow valleys. Steep slopes. Wooded. No lakes.	92,772	363.00	255	0.0783	....	Quoted by W. R. Hutton.
Potomac.....	Great Falls	11,476.00	12	13	9	8	42	244	Country more open. No lakes.	....	1,063.00	....	0.093	....	W. R. Hutton.
Rock Creek..	Hoyle's Mill	64.40	11	12	11	8	42	18	....	....	7.50	....	0.114	0.458	Quoted by W. R. Hutton.
Kanawha....	Charleston pool ...	8,900.00	12	13	9	10	44	270	Mountainous. Steep. No lakes. Wooded.	120,000±	1,100.00	110	0.123	....	Gill, Scott, and Hutton.
Greenbriar ..	Mouth of Howard's Creek.	870.00	11	12	8	9	40	60	Mountainous. Steep. No lakes. Wooded.	....	97.00	....	0.120	....	McNeill.
Shenandoah .	Near Port Republic.	770.00	12	13	8	8	41	....	Hilly. Limestone. No lakes. Many springs.	....	128.00	....	0.167	....	James Herron.
James	Richmond	6,800.00	12	12	9	10	43	....	Mountainous in upper part. No lakes. Wooded.	....	1,300.0+		0.191	....	H. D. Whitcomb and W. E. Cutshaw.
Neuse	Near Raleigh	1,000.00	12	13	10	10	45	....	Open. Clay and loam. No lakes. Few extensive woods.	....	....	....	....	0.193	W. C. Kerr, low water.

Table of monthly flow in dry years.

Rivers.	Drainage area, square miles.	Flow in inches on water-shed. Driest month.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.	Eleventh.	Twelfth.	Total for the year.	Ratio of monthly to mean flow. First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.	Eleventh.	Twelfth.
Croton	339	0.20	0.35	0.53	0.63	0.87	0.94	1.52	1.63	1.80	1.90	2.08	2.27	14.72	0.16	0.25	0.43	0.51	0.71	0.77	1.24	1.33	1.47	1.55	1.70	1.85
Concord	352	0.25	0.32	0.36	0.43	0.54	0.68	0.85	1.07	1.36	1.70	2.15	3.62	13.33	0.22	0.29	0.32	0.39	0.45	0.61	0.76	0.96	1.23	1.53	1.94	3.26
Merrimack	4,136	0.68	0.70	0.77	0.85	1.00	1.13	1.30	1.53	1.98	2.55	3.22	5.42	21.13	0.38	0.40	0.44	0.48	0.57	0.64	0.74	0.87	1.12	1.45	1.83	3.08
Connecticut	10,234	0.65	0.68	0.71	0.74	0.88	0.96	1.28	1.51	1.80	2.02	3.28	4.71	19.16	0.41	0.43	0.45	0.46	0.55	0.56	0.80	0.95	1.13	1.26	2.05	2.95
Schuylkill*	1,800	0.27	0.30	0.38	0.40	0.53	0.62	0.68	0.70	0.88	0.98	1.08	1.59	8.50	0.38	0.42	0.54	0.57	0.75	0.86	0.96	1.12	1.24	1.38	1.52	2.24

Table of monthly average flow for a series of years.

Croton	339	0.56	0.95	1.12	1.21	1.43	1.82	2.30	2.57	2.77	3.02	3.60	4.00	25.35	0.26	0.45	0.53	0.57	0.68	0.86	1.09	1.21	1.31	1.43	1.70	1.90
Concord	352	0.39	0.46	0.51	0.61	0.76	0.96	1.25	1.52	1.92	2.38	3.00	4.86	18.62	0.25	0.30	0.33	0.39	0.49	0.62	0.81	0.98	1.24	1.53	1.93	3.13
Merrimack	4,136	0.77	0.88	1.06	1.26	1.52	1.80	2.12	2.49	3.03	3.73	4.63	6.56	29.85	0.31	0.36	0.43	0.51	0.61	0.72	0.85	1.00	1.22	1.50	1.86	2.63
Connecticut	10,234	0.75	0.85	0.91	1.10	1.34	1.58	2.00	2.36	2.81	3.27	4.52	6.26	27.75	0.33	0.37	0.39	0.47	0.58	0.68	0.87	1.02	1.21	1.41	1.96	2.71

Table of monthly flow in dry years of streams of small drainage area.

Cochituate	19.00	0.08	0.41	0.46	0.47	0.70	0.88	0.97	1.03	1.11	1.31	1.47	2.26	11.15	0.09	0.14	0.50	0.51	0.75	0.95	1.03	1.11	1.20	1.41	1.58	2.43
Croton, Western Branch	20.37	0.10	0.17	0.46	0.53	0.67	0.84	0.98	1.02	2.31	3.37	3.41	5.40	19.26	0.06	0.10	0.28	0.33	0.42	0.52	0.61	0.64	1.44	2.10	2.13	3.37
Sudbury	76.30	0.11	0.16	0.25	0.39	0.57	0.79	1.06	1.40	1.79	2.21	2.77	5.09	16.59	0.08	0.11	0.18	0.28	0.41	0.57	0.77	1.01	1.29	1.60	2.01	3.69
Passaic headwaters	50–100	0.11	0.15	0.21	0.27	0.49	0.67	0.90	1.22	1.77	1.87	2.13	3.65	13.44	0.10	0.13	0.19	0.24	0.44	0.60	0.80	1.09	1.58	1.67	1.90	3.26

* Charles G. Darrach, in *Engineering News*, April 3, 1880, p. 122.

The month of least flow (the driest month) varies considerably from year to year, falling sometimes in the summer and sometimes in the winter, and the months do not succeed each other in the order of dryness. As a rule, however, the driest months fall in summer, although sometimes the difference is not very pronounced. (See a paper by Mr. Clemens Herschel, "The Gauging of Streams." *Transac. Am. Soc. Civ. Engrs.*, vol. vii, 1878, p. 236.) The last three tables are principally from Mr. Croes' report to the Newark Aqueduct Board.

In describing the separate water-powers I have therefore given four estimates. For convenience of reference I will recapitulate them here, noting briefly their exact meaning:

1. ABSOLUTE MINIMUM can be depended upon *always*, and with no storage at all. Large waste all the time, except for a few days at a time in intervals of several years.

2. MINIMUM LOW-SEASON FLOW, with no storage, can be depended upon at all times, except for a short time in some dry seasons—perhaps for a few days in the dry season of each year. With small storage can be depended upon all the time.

3. MEAN FLOW IN VERY DRY YEARS.—*Maximum amount permanently available with storage.* Storage capacity as already discussed. With larger storage a greater amount could perhaps be utilized for several years in succession, but not permanently.

4. LOW-SEASON FLOW IN ORDINARY DRY YEARS, without storage, can be depended upon generally, except in the low season of dry years, when the supply will be deficient for, perhaps, several weeks; in very dry years, when the supply will be deficient for a longer time, and in ordinary years, when the supply may be deficient for a few days at a time; can be rendered permanently available by storage. *The low-season flow of ordinary years* can be depended upon less than the above, but generally for nine months of every year.

TIDAL WATER-POWER.

There is no tidal power either used or available in the district considered, partly because there are no facilities for storing water, and partly because, as is evident from the topography of the country, there are no facilities for location of buildings on a low and swampy coast.

TOTAL AVAILABLE POWER.

It is customary to attempt to estimate the total available power of a district by assuming the average elevation and the quantity of water discharged. Such estimates have little value, because a large proportion of the power so estimated is, in fact, unavailable, on account of topographical features. In regard to the region under consideration, however, it is to be noticed that as the elevation of the Atlantic plane, at the foot of the mountains, is much greater than in the states farther north, varying from 1,200 feet in North Carolina, at the sources of the Catawba, to 500* feet in Virginia and 100 to 300 feet in Pennsylvania,* the total theoretical power in the region we are considering will be very large in proportion to its area, especially if we exclude the eastern division from consideration.

After having presented the general features of the district under consideration, briefly pointed out the general principles relating to the amount of power available, and explained the method used in calculating it, it is now only necessary to show how, in the application of those principles, the general characteristics of the region show their effects and are to be taken into account.

6.—General results.

1. It follows from the position of the region that the warm and moist SW. winds from the Gulf of Mexico traverse its whole extent. Hence the rainfall is greatest (62 inches) in Alabama and southern Georgia, while the evaporation is comparatively small, because the air is moist, and the rainfall diminishes to 44 inches and less in North Carolina and Virginia, while the air becomes drier and the evaporation greater. Above North Carolina the greater part of the rain comes from the Atlantic, while south of Virginia most of it comes from the Gulf. This fact—that the evaporation increases toward the north—has an important bearing on the flow of the streams, which will be referred to further on.

2. From the topography it follows that all the water-power of importance is in the middle division. In the eastern division the streams are too sluggish, and in the western they are too small and inconstant. Although the middle division is very favorably disposed for water-power, it is unfortunate that in the eastern division, just where the streams are the largest, the conditions are not favorable. The middle division is, topographically, very favorable for power. The fall of the streams is great, but as a whole tolerably uniform, and their volume moderately large. They cross the ledges of rock at large angles, forming many rapids, rifts, or falls in all parts of this region. These ledges, being composed of hard, durable, and impervious rocks, generally granite or similar rocks, insure the permanence of the powers, and afford everywhere good sites for dams. The shape of the river valleys is such as to render the utilization of the power in most cases easy, there being only a very few instances of anything approaching the cañon structure. The facilities for storing water are, on the whole, good, though the shape of the valleys does not seem to be *particularly* favorable; for in the mountains the fall is too great and the valleys too narrow to afford *large* reservoir room, while lower down the rivers are bordered by fertile bottom-lands, which it might be inadvisable to overflow, and besides, as the streams are tolerably large, it would be difficult to store sufficient water to increase the power much. In the matter of storage this region is notably less favorable than such states as Maine and Pennsylvania. The absence of lakes, also, operates unfavorably on the volume and constancy of the streams, especially in the upper parts, and this is counteracted by the action of the forests perhaps to a less extent than might be supposed. (See below.)

The country in the middle division being moderately hilly, the rainfall is neither precipitated suddenly into the river channels, rendering them subject to sudden freshets, nor is it discharged too gradually, so as to render the evaporation abnormally large. On the contrary, the depth and perviousness of the soil, the fact that it is everywhere underlaid with hard and impervious rock, and that the rivers have cut their channels down to this rock-bed, contribute to the volume and constancy of the streams, and diminish the loss by evaporation and by subterranean flowage. This depth of soil, serving to store the waters, is especially beneficial in view of the variability of the rainfall, in which respect some parts of this region stand at a disadvantage, which is thus, to some extent, compensated for. In Maine, for instance, the soil is very shallow compared with that in North Carolina, but the rainfall is very equally distributed throughout the year. (See page 17 for further remarks on this subject.)

3. The influence of the forests in the western division is favorable, yet not to such an extent as might be supposed, according to what has been said regarding the influence of woods in winter and in summer. In fact, there is reason to believe that at least in the northern parts of the region considered less water percolates into the ground in winter, to be stored and given out by springs, than in open ground. From the experiments which have been referred to, the conclusion has been drawn for Germany that the cutting down of forests has the effect in winter of increasing the discharge of springs and causing a higher average stage of the water in the streams than existed before.† In hot regions, and in summer, the cutting down of woods has the opposite effect, but it does not seem improbable that, for the district considered, the effect would be to a certain extent as stated, especially if (as is the case in the western part of the district in many cases) the rainfall is greater in winter than in summer. For this reason it is easy to overestimate the effect of the forests as regulators of flow. Their effect is certainly very much smaller than in regions where the rainfall is greater in summer than in winter, in which case their effect is very beneficial and only exceeded by that of lakes or artificial reservoirs and surface materials. The fact that the

* Guyot.

† Ebermayer: *Die physikalischen Einwirkungen des Waldes auf Luft und Boden, und seine klimatologische und hygienische Bedeutung.* Berlin, 1873, p. 223.

mountains in this district are covered with soil is one of great importance, and on this account the flow of the streams will be much more constant than it would otherwise be.

4. I have already alluded to the winds and the position of this region as affecting its water-power. As regards temperature, it is, of course, higher in this region than in New England. In summer the difference is some 12°; in winter, over 20°; and for the year, in the middle division, 12° to 15°. The average temperature in winter is far above the freezing point; hence the streams rarely freeze over. Trouble with ice is almost unknown, and, in this respect, this region has a great advantage over the more northern states, which is, however, partially offset by the fact that the evaporation is greater.

Mr. Wells, in his report on the water-power of Maine, dwells upon the fact, which he says is founded on the testimony of persons who have had the largest and most varied experience in manufacturing in Maine and other states, that operatives can accomplish much more in winter than in summer, or in cold than in warm states. I quote Mr. Wells' remarks on this point:

It is well known that at the large majority of manufacturing labors the burden of the day's work is felt by the operative to be much heavier in summer than in winter. The cold of the latter season can be so guarded against and mollified that throughout the whole establishment precisely, or very nearly, that temperature can be secured which is most contributive to vigorous exertion. But the heat of summer, pervading and penetrating everything, and brought in at every open window with the necessary supplies of fresh air, cannot be shut out. It cannot be qualified. It oppresses the worker with a languor rarely experienced in out-of-door avocations, and renders it impossible for him to do so much or do so well as he can easily do in cool weather. Accordingly, the evidence is that in Maine, where the summer temperature is low, where it rises above the point of comfort for but a few days for the whole season, operatives, circumstanced equally in every other respect, accomplish more than in the interior and more southern states by the truly remarkable fraction of 10 per cent.

It must, however, be borne in mind that although in warmer climates the operatives are unable to accomplish so much, yet, on the other hand, the expense for heating the factory buildings is greatly reduced, and that, further, as the operatives can live more cheaply on account of not needing so much artificial heating in their houses, their wages may be much less in proportion. In fact, it is stated that the wages paid to operatives in cotton factories in the southern states is 34 per cent. less than in the New England states.* The table of maximum observed temperatures shows that the maximum observed temperature in Maine is about the same as in Georgia. The following table of the mean temperatures of the hottest and coldest months of the year will enable a comparison to be made between the New England states and the southern states, and will show that the difference is not so great as is generally supposed.

Table of mean temperatures of hottest and coldest months in various places.

Place.	Number of years of observation.		Mean temperatures of hottest month.	Mean temperatures of coldest month.
	Yrs.	*Mos.*	*Degrees.*	*Degrees.*
Bath, Me	10	7	68.71	23.22
Castine, Me	40	0	64.82	21.41
Brunswick, Me	51	3	67.44	20.10
Newport, R. I	34	8	70.98	25.84
Providence, R. I	40	0	70.14	29.40
New Haven, Conn	86	0	71.69	26.46
Hartford, Conn	16	7	72.14	29.11
Manchester, N. H	14	1	72.94	23.84
New York, N. Y	24	5	72.93	29.36
Newark, N. J	21	11	75.06	29.78
Philadelphia, Pa	51	0	75.20	29.40
Harrisburg, Pa	29	3	78.63	30.67
Baltimore, Md	36	0	77.35	33.00
Washington, D. C	12	3	78.26	34.09
Fortress Monroe, Va	45	5	78.73	41.10
Fort Johnston, N. C	15	10	81.64	49.10
Chapel Hill, N. C	20	0	78.33	40.40
Asheville, N. C	6	6	74.00	37.00
Aiken, S. C	8	8	78.80	44.15
Camden, S. C	9	9	80.64	42.71
Charleston, S. C	24	8	80.22	49.38
Columbia, S. C	4	11	78.78	48.71
Fort Moultrie, S. C	32	11	81.94	50.28
Athens, Ga	6	6	76.33	44.58
Atlanta, Ga	5	2	77.50	40.90
Augusta, Ga	21	7	82.16	46.08

*Address of Hon. E. Steadman, before the convention of the Georgia State Agricultural Society, August, 1876. According to the census of 1870, the average wages paid to operatives in cotton factories in various states was as follows, in dollars, per annum: Maine, 272; New Hampshire, 311; Vermont, 277; Massachusetts, 311; Rhode Island, 310; Connecticut, 270; Pennsylvania, 276; Maryland, 236; Virginia, 132; North Carolina, 130; South Carolina, 230; Georgia, 222. The wages will depend somewhat on the quality of goods manufactured, but the average is evidently much less in the south.

Most of the stations in the southern states are in the eastern division, where the weather is much warmer than in the middle and western divisions, where the water-power is. The table shows that at Athens and Atlanta, Georgia, which are the best types of the middle section, the mean temperature of the warmest month is not much different from that in the middle states, although Maine, it is true, has a lower temperature by some 10°. It seems to me, however, that this effect of temperature has been overestimated, and that, so far as it alone is concerned, the advantages in the southern Atlantic states more than counterbalance the disadvantages.

5. As regards the rainfall, its distribution throughout the year on the water-shed of each river is to be carefully considered. Variability in this distribution may not be a disadvantage, but on the contrary, if the summer fall is greater than the winter fall, the flow of the streams will be more regular, other things being equal. In determining the ratios to be used in estimating flow I have been influenced by this consideration, and if of two streams, similar in other respects, one has more rain in summer than in winter, and the other more in winter than in summer, I have taken the minimum flow of the former considerably greater than that of the latter. Differences in the evaporation in different parts of the district also come into consideration. If the other climatic conditions remained the same, the effect of variability in the rainfall would be seen in a corresponding variation in the flow of the streams, and in those seasons when most rain fell the flow of the streams would be greater. Yet in the New England states, as well as in the southern states, the streams are lowest in summer, even when more rain falls in that season, showing that the evaporation in that season is more than sufficient to make up for the greater rainfall. It is true that in the North there is a winter drought, caused by the snow lying so long on the ground, so that little of the precipitation reaches the streams; yet, although in some cases the driest month, or the month when the streams are lowest, falls in the winter, in general the summer drought is greater than the winter drought. On account of the increased evaporation, the southern streams will, in all probability, discharge a smaller proportion of the rainfall on their drainage areas than those in New England. Finally, the effect of soil and lakes must not be overlooked in comparing this region with New England, and in estimating the flow of the streams.

The foregoing remarks have been made because it is necessary to present the principles which have guided me in making my estimates. The conditions determining the flow are, however, so various, that they cannot all be given due weight, even if they were all accurately known; so that the only safe guide in practical questions regarding flow is a series of gaugings extending over a number of years. But as I have not a single such series for the district considered I am obliged to resort entirely to estimate. Every engineer can form his own conclusions from the data at hand, and many may not be disposed to approve of the figures given.

I.—THE CHOWAN RIVER AND TRIBUTARIES.

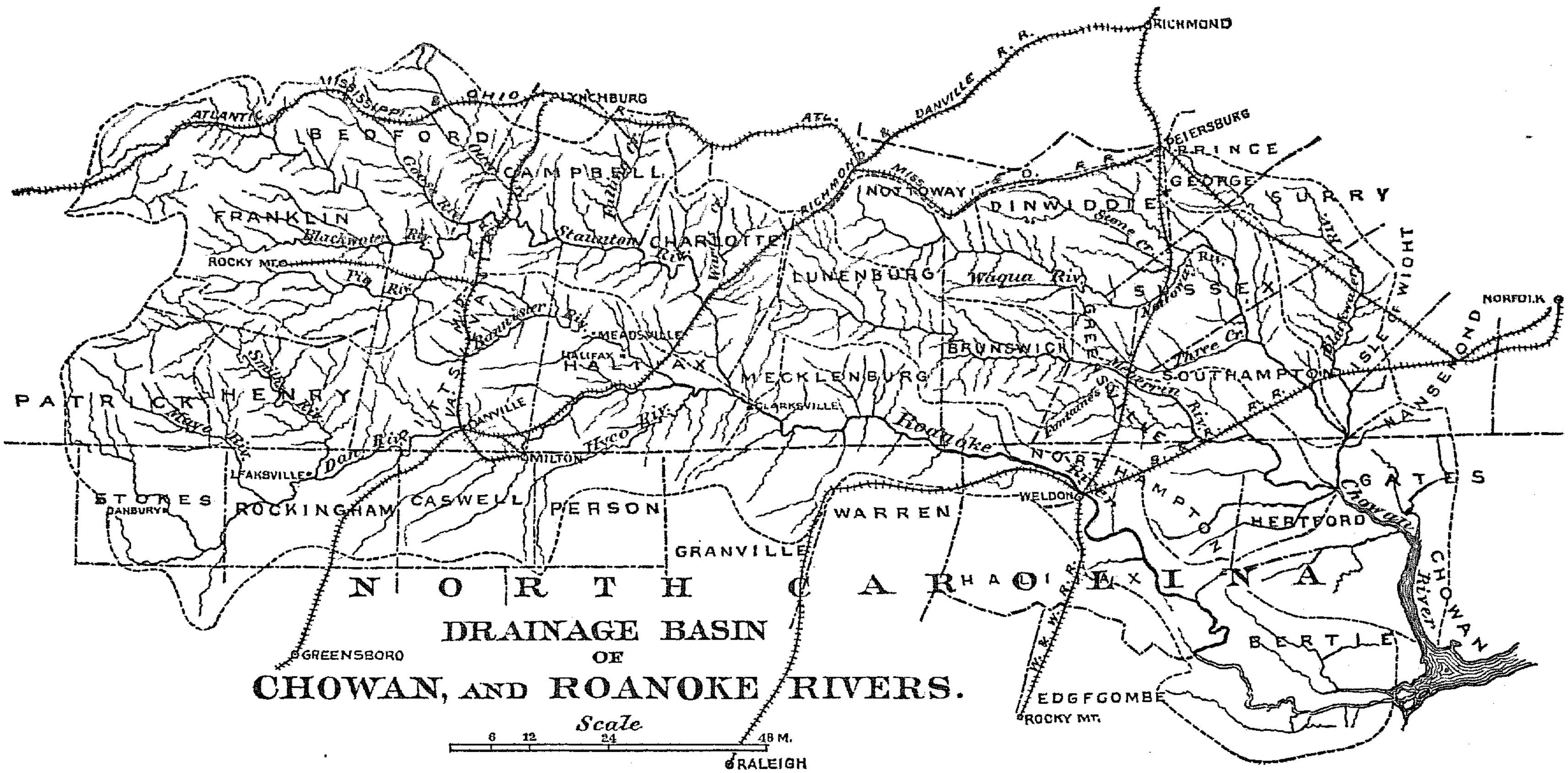
THE CHOWAN RIVER.

The first river south of the James worth considering is the Chowan, for although there is no water-power on the main stream there is some on the tributaries. The Chowan is formed by the junction of the Blackwater and Nottoway rivers, nearly on the line between North Carolina and Virginia, whence it flows nearly south into Albemarle sound, between Hertford and Bertie counties on its right and Gates and Chowan on its left, entering the sound at its western extremity. It is navigable for its whole length—about 38 miles in a straight line, and perhaps 60 by the river. Its total drainage area is about 4,870 square miles, and its principal tributary is the Meherrin, which enters from the west. It flows, with a sluggish current, through a low and swampy country, entirely below the fall-line, with large portions subject to overflow at times, and possesses no water-power whatever, used or available. The principal town on the river is Winton, the county seat of Hertford county. The trade on the river is of considerable importance, large quantities of cotton, corn, wheat, tobacco, lumber, and fish being shipped.

THE MEHERRIN RIVER.

This stream is the most important tributary of the Chowan. It rises in Charlotte, Lunenburg, and Mecklenburg counties, Virginia, flows a little south of east, forming the boundary between Lunenburg and Mecklenburg counties; thence flows through Brunswick and Greenville, and between Greenville and Southampton counties, Virginia, and finally through Hertford county, North Carolina, emptying into the Chowan several miles above Winton. Its length, in a straight line, is about 100 miles, but is considerably greater by the river. It is navigable beyond the North Carolina line, a distance by the river of over 30 miles. The principal towns on the stream are Murfreesboro', North Carolina, about 15 miles from the mouth, and Hicksford, Virginia, about 50 or 60 miles from the mouth.

The drainage area of the Meherrin comprises about 1,675 square miles, about half of which lies below the fall-line, and in which the river is a sluggish stream, with a bed of clay or sand, and perhaps occasionally a ledge of rock. Its banks are subject to overflow, and the adjacent bottoms or low grounds are covered with extensive cypress swamps and pine woods. In this part of the river there is, of course, no water-power. Above the fall-line the country is not so level, the bed of the stream is more rocky, and the banks are not so subject to overflow, although there are still extensive low grounds which are flooded at times. The soil is sand and clay, and very fertile; the country well



DRAINAGE BASIN OF CHOWAN, AND ROANOKE RIVERS.

Scale

6 12 24 48 M.

wooded, and the principal products are cotton, corn, wheat, tobacco, fruits, and vegetables. This part of the drainage-basin belongs geologically to the Eozoic formation, while that below the fall-line is Tertiary or later. The fall of the stream is nowhere very great, and the divides, separating its drainage-basin from the adjacent ones, are nowhere very high, so that the tributaries also have no very great fall. The latter, however, are small, and not of much importance, and I have only measured the drainage areas of a few of them. The results, together with the drainage areas above various points on the main stream, are given in the table on page 26.

The average rainfall on the drainage-basin of the Meherrin is about 44 inches, or a little less, of which about 11 fall in spring, 13 in summer, 8 in autumn, and 10 in winter. There are no lakes in the basin; neither are the facilities for the construction of storage reservoirs very good, the country being too flat.

The fall of the river in the last 30 miles of its course is not much over 1 foot to the mile, the elevation above mean tide of the mean water-surface of the stream at the crossing of the Seaboard and Roanoke railroad, some 30 miles from its mouth, being 31 feet.

According to an old survey by J. Williston, whose report is to be found in the twenty-second report of the board of public works of Virginia, the fall varies from 1 to 3 feet per mile.

In the entire absence of gaugings of the river its flow would have to be estimated, but I have made no estimate because of the small value of the stream as a source of power.

The water-power of the Meherrin and its tributaries is not of great importance. The flow of the stream is extremely variable, and no sites of importance were brought to my notice. Although the river crosses the fall-line in the vicinity of Lawrenceville or Hicksford, where we should expect to find a fall, I succeeded in obtaining no information regarding any power in that neighborhood. There seems to be no fall on either the Meherrin or the Nottoway at its crossing of the fall-line, although this line is very marked in the case of the Appomattox and the Roanoke. The river, however, is very inaccessible, especially above the fall-line—so much so that I did not consider it advisable to visit it at any point above—and it is therefore possible that there may be a power somewhere in this neighborhood. With the exception of the Petersburg railroad, which crosses the river near Hicksford nearly at right angles, no other railroad comes within 15 or 20 miles of the stream.

As to building materials, there is abundance of fine timber in all parts of the drainage-basin, and in some parts above the fall-line granite and similar rocks may be found.

The country is sparsely settled, and the people have given very little attention to the subject of water-power, so that little satisfactory information could be obtained with the time at disposal. The power utilized on the stream will be found tabulated from the reports of the enumerators, on page 27.

THE BLACKWATER RIVER.

This stream rises in Prince George county, Virginia, flows in a direction rather east of south between Surry, Isle of Wight, and Nansemond counties on its left, and Sussex and Southampton on its right, joining the Nottoway, on the North Carolina line, to form the Chowan; its length in a straight line being about 55 miles. It is navigable to the town of Franklin, the head of tide-water,* on the Seaboard and Roanoke railroad, about 13 miles from the mouth of the river. It drains an area of about 700 square miles, lying entirely below the fall-line, and possessing little water-power. The river is sluggish and tortuous, flowing mostly through cypress swamps with dense undergrowth, its width varying below Franklin from 100 to 275 feet, and its depth from 8 to 38 feet. Large areas are flooded at high water, although the extreme rise is not over 3 or 4 feet.* The fall of the stream for 22 miles above Franklin is not over 1½ or 2 feet to the mile, and for the next 7 or 8 miles only very slightly greater.† The elevation of the stream at the crossing of the Atlantic, Mississippi and Ohio railroad, about 15 miles above Franklin, is about 17½ feet above mean tide at Norfolk.‡ According to an old survey,§ the divide between the Blackwater and the Nansemond, which flows into the James, is nowhere more than 83 feet above tide.

The rainfall on the drainage-basin of the Blackwater is the same, and similarly distributed, as on that of the Meherrin. Estimates of flow are not necessary, on account of the absence of water-power on the river.

The river is accessible from stations on the Seaboard and Roanoke and the Atlantic, Mississippi and Ohio railroads, the latter of which follows the river for some 35 miles at a distance from it of only 3 or 4 miles.

THE NOTTOWAY RIVER.

This river rises in Prince Edward, Lunenburg, and Nottoway counties, Virginia, and flows in a general direction nearly southeast through a very fertile country, forming first the boundary between Nottoway and Dinwiddie counties on its left and Lunenburg and Brunswick on its right, thence flowing through Sussex and Southampton, joining the Blackwater, on the North Carolina line, to form the Chowan. The principal town on the stream is Jerusalem, Virginia. The length of the stream, in a straight line, is about 90 miles, and probably over 125 if its windings are followed. The table on page 26 gives particulars regarding drainage areas, the total area drained being about 1,650

* Annual reports Chief of Engineers, 1879, appendix G 12, p. 620; 1878, appendix G 12, p. 522; 1875, p. 161.

† Old survey, in one of the reports of the board of public works of Virginia.

‡ For the elevations on the Atlantic, Mississippi and Ohio railroad I am indebted to Mr. Hunter, of Petersburg, engineer of the road.

§ In the twenty-second report of the board of public works of Virginia.

square miles, divided nearly in two equal parts by the fall-line. The head of tide-water is at the crossing of the Seaboard and Roanoke railroad at Nottoway, some 12 miles from the mouth of the stream.* The tributaries of the Nottoway are not of much consequence, the principal ones being Assamoosick, Rowanty, Stony, and Little Nottoway creeks from the north and east, and Three creek and Waqua creek from the south and west. It is noticeable here, as elsewhere, that the principal tributaries enter from the northern side of the water-shed, a fact already referred to.

The Nottoway is now being improved by the government, the present project having in view the securing a navigable depth of 4 or 5 feet during nine months of the year as high as Peter's bridge, something over 50 miles above the mouth of the stream, and 20 miles above the town of Jerusalem. Five thousand dollars have been appropriated for the work, and the principal obstructions to navigation, which consist of snags, sunken logs, and overhanging trees, are being removed. It is expected that at low water a navigable depth of 2 or 3 feet will be secured as high as Peter's bridge, and of 7 or 8 feet as high as Monroe's ferry, about 15 miles from the mouth of the river, measured along its course. The drainage areas of some of these tributaries are given in the table of statistics. The principal products of the country drained by the Nottoway are cotton, corn, peanuts, tobacco, and wheat. As in the case of the Meherrin, I heard of no power on the Nottoway at the point where it crosses the fall-line. But in one of the reports of the board of public works of Virginia I found an account of a survey of the river, in which "the Great falls, on the south prong", were mentioned, situated 9¾ miles above the mouth of the Little Nottoway; and it was stated that the river there was 37 feet wide, with an average depth, at low water, of 23 inches, discharging 31 cubic feet per second. I did not consider it worth while to visit so small a power. The drainage-basin of the Nottoway is similar in all respects to that of the Meherrin as far as I could learn, so that it need not be described. The rainfall is also about the same; estimates of the flow are not necessary. No gaugings could be found for this river except the one mentioned above.

There are no lakes on the stream, and not very good facilities for reservoirs. The bed is in some places rock, but generally sand, gravel, and clay. Below the crossing of the Petersburg railroad the river has an average width of about 68 feet, with banks 10 or 15 feet high, and a bed of coarse gravel, and occasionally sand, loosely deposited on a friable sandstone.† On the lower part there are considerable areas of low ground, sometimes overflowed. According to an old report, the stream is 30 to 40 feet wide and 16 inches deep at low water for 10 miles above the mouth of the Little Nottoway; the current is gentle and the bed sandy. The Nottoway is more accessible than the Meherrin, being nearer to the Atlantic, Mississippi and Ohio railroad, the nearest road on the north.

I did not visit any sites or mills on the river, having been informed that they were unimportant. The same report which mentioned the falls on the south prong referred also to a power at "Spencer's mill", where there was said to be a fall of 12 to 15 feet; but I was unable to learn more particulars regarding this place, and did not consider it worth while to devote much time to searching for it. The country is sparsely settled, and the people have given little attention to water-power, so that without a personal examination of the river little satisfactory information could be obtained.

The tributaries of the Nottoway have some power, as is shown by the statistical table, but it will be seen that the only mills in this vicinity are grist- and saw-mills. There is no further manufacturing of any kind by water-power in the drainage-basin of the Chowan.

From what has been said, it seems that the tributaries of the Chowan offer little water-power, and are not, as a rule, favorable streams for manufacturing. The facilities for storage are small, the flow is variable, on account of the large evaporation, and the bed and banks are not very favorable for dams. There is, of course, some power available, but it is, according to all accounts, not very considerable.

Table of drainage areas of the Chowan river and tributaries.

River and place.	Drainage area.
	Square miles.
Chowan, at mouth	4,870
Meherrin, at lower edge of Lunenburg county	376
Meherrin, at lower edge of Brunswick county	671
Meherrin, at lower edge of Greenville county	1,070
Meherrin, at mouth	1,675
Fontaine's creek, at mouth (tributary of Meherrin)	288
North Meherrin, at mouth (tributary of Meherrin)	100
Middle Meherrin, at mouth (tributary of Meherrin)	85
South Meherrin, at mouth (tributary of Meherrin)	84
Blackwater, at mouth	700
Nottoway, at lower edge of Nottoway county	280
Nottoway, at lower edge of Dinwiddie county	475
Nottoway, at mouth of Rowanty creek	800
Nottoway, at lower edge of Sussex county	1,080
Nottoway, at mouth	1,650
Rowanty creek, at mouth (tributary of Nottoway)	125
Stony creek, at mouth (tributary of Nottoway)	210

* For the elevations of streams crossed by the Seaboard and Roanoke railroad I am indebted to the president, Mr. John M. Robinson.

† Twenty-first report board of public works of Virginia; report on survey by John Williston.

Table of utilized power of the Chowan river and tributaries.

Stream.	Tributary to what.	State.	County.	Kind of mill.	Number of mills.	Total fall used.	Total h. p. used.	Wheel.
						Feet.		
Chowan	Albemarle sound				0	0	0	
Meherrin river	Chowan	North Carolina	Northampton	Saw	1	9	12	
	Do	Virginia	Southampton	Flour and grist	1	5	10	
	Do	do	Greenville	do	3	31	64	
	Do	do	do	Cotton-gin	2	21	12	
	Do	do	Brunswick	Flour and grist	3	29	65	
	Do	do	Mecklenburg	do	4	35	78	
	Do	do	do	Saw	1	12	22	
	Do	do	Lunenburg	do	1	16	19	
Tributaries to	Meherrin	North Carolina	Hertford	Flour and grist	8		57	
	Do	do	Northampton	do	6	29	70	
	Do	do	do	Saw	2	8	16	
	Do	Virginia	Southampton	Flour and grist	2	17	14	
	Do	do	Greenville	do	6	57	83	
	Do	do	do	Cotton-gin	3	28	35	
	Do	do	do	Foundry	1	10	15	
	Do	do	Brunswick	Flour and grist	9	133	128	
	Do	do	do	Saw	2	31	17	
	Do	do	Mecklenburg	Flour and grist	1	20	12	
	Do	do	Lunenburg	do	6	122	150	
	Do	do	do	Saw	2	37	35	
Blackwater river	Chowan	Virginia	Surry	Flour and grist	1	8	8	
Tributaries to	Blackwater	do	Nansemond	do	6	59	76	
	Do	do	do	Saw	1	10	25	
	Do	do	Southampton	Flour and grist	7	82	133	
	Do	do	Isle of Wight	do	3	11½	39	
	Do	do	do	Saw	3	15½	55	
	Do	do	Surry	Flour and grist	2	16	18	
Nottoway river	Chowan	do	Southampton	do	3	23	46	
	Do	do	Greenville	do	1	9	8	
	Do	do	Dinwiddie	do	2	21	42	
	Do	do	Nottoway	do	1	26	20	
	Do	do	do	Saw	1	26	28	
	Do	do	Prince Edward	do	1	23	6	
	Do	do	do	Flour and grist	1	23	6	
Tributaries of	Nottoway	do	Southampton	do	4	45	83	
	Do	do	do	Cotton-gin	3		17	
	Do	do	Sussex	Flour and grist	8	67	165	
	Do	do	Dinwiddie	do	3	32	47	
	Do	do	do	Saw	1	2	7	
	Do	do	Brunswick	Flour and grist	6	64	58	
	Do	do	Lunenburg	do	1	20	10	
	Do	do	Nottoway	do	3	69	27	
	Do	do	do	Saw	2	49	15	
	Chowan	North Carolina	Chowan	Flour and grist	1	7	8	
	Do	do	Gates	do	2	18	71	
	Do	do	do	Saw	1	9	30	

II.—THE ROANOKE RIVER AND TRIBUTARIES.

THE ROANOKE RIVER.

This river is formed by the confluence of the Dan and Staunton rivers, in Mecklenburg county, Virginia. Thence flowing southeast, it enters North Carolina in Warren county, and forms the dividing line between Halifax and Martin counties on its right, and Northampton and Bertie on its left, emptying into Albemarle sound just above Plymouth. The total length of the river is about 125 miles in a straight line, and probably nearly twice as far by the river. The principal towns on the stream are: Clarksville, Virginia (just below the junction of the Dan with the Staunton), Weldon, Halifax, Hamilton, Williamston, and Plymouth, North Carolina. The stream is navigable at low-water to Weldon (some 120 miles), or can be made so for boats drawing 2 or 3 feet, and to Hamilton (60 miles) for boats drawing 10 feet. Boats of greater draught cannot come through the sound. It is considered possible to get a low-water navigation of 5 feet to Weldon,* the principal obstacles to navigation being snags,

* Annual Reports Chief of Engineers, 1872, p. 726; 1879, p. 624.

stumps, and sand-bars. By a system of locks and dams this river, with the Dan, was long ago made navigable to Danville, more than twice as far from the mouth as Weldon, but these old canal-works have been long in disuse, although the company which built them—the Roanoke Navigation Company—has continued in existence down to the present time. Although Weldon is now the head of navigation, yet there are still long reaches on the Roanoke and on the Dan, both above and below Danville, which are boatable.

The total area drained by the Roanoke river comprises about 9,200 square miles, of which the Dan drains 3,700, the Staunton 3,450, and the Roanoke below the junction 2,050. There are no large tributaries of the Roanoke below the confluence of the Dan and Staunton, although a number of small creeks flow into it from both sides.

The drainage-basin of the Roanoke proper is divided into two nearly equal parts by the fall-line, which crosses the river between Weldon and Gaston, North Carolina. That part of the water-shed below Weldon is low and flat, and partakes of the general characteristics of the eastern division, and therefore need not be described here in great detail. Above Weldon the country is more broken and the river has more fall, having cut its bed down to the underlying metamorphic rocks. The drainage-basin is long and narrow, varying in width from 10 to 30 miles, and along the river are many fine bottoms, among which are some of the best farming-lands in the vicinity. The bottoms widen out as we descend the river, and the flood-plain spreads out in places to a width of several miles, and finally is represented by the broad lowlands and cypress swamps of the eastern division. Alternating with the bottoms are bluffs, especially on the south side of the river. The proportion of the drainage-basin covered with forests I have not been able to ascertain. The soil is clay and loam, with sand in the lower part of the basin, and the productions are tobacco, corn, wheat, fruits, and vegetables. Below Weldon the country is heavily timbered, and large quantities of timber and shingles are shipped. It is said that between 15,000,000 and 20,000,000 shingles are made and shipped annually from this region. Above Weldon fine building-stone is found in many places, and in Granville, Warren, Edgecomb, and Wilson counties, North Carolina, a fine quality of granite is quarried. Near Gaston there is a deposit of specular iron-ore, which has been very little worked. The basin is thinly settled above Weldon, and the river is quite inaccessible, as will be seen from the map. The Raleigh and Gaston railroad, after leaving the river at Gaston, recedes rapidly from it, and afterward comes nowhere within 8 or 10 miles of it; while on the north the nearest railroads, the Richmond and Danville and the Atlantic, Mississippi and Ohio, are, on an average, 35 miles distant. Before the war Clarksville had railroad connection with the Raleigh and Gaston road, and was a thriving tobacco mart, but the road was torn up during the war to repair other roads, and has never been rebuilt,* in consequence of which the town has decreased considerably in population.

The average rainfall on the water-shed of the Roanoke above the fall-line is probably 40 or 42 inches, varying from 38 or 39 on the upper part of the Staunton to 44 inches at Gaston. Of this amount 10 or 11 inches fall in spring, about 10 inches in summer, and nearly the same in autumn and winter. Being so uniformly distributed, the flow of the stream may be expected to be very variable, especially as in all probability the evaporation is quite large; and, in fact, the general testimony is that the flow of the stream is subject to very large variations.

The freshets on the river are very violent and the fluctuations often occur very rapidly. At Weldon an ordinary freshet gives a rise of 12 or 15 feet; but generally twice in the year, in the spring and in the fall, there is a larger freshet, the water rising 25 to 30 feet. In 1865 the river rose 50 feet at that point, and 30 feet at Hamilton. For 60 or 70 miles below Weldon the rise is from 20 to 50 feet, but it gradually diminishes as the mouth of the river is approached, and for the last 15 or 20 miles of its course it is from 1 to 3 feet.† These floods occur so rapidly that the river rises sometimes over 10 feet in a day at Weldon,‡ and of course they overflow the banks and flood large areas of the adjoining lands.

There are no lakes or artificial reservoirs anywhere in the drainage-basin, neither are there facilities for storage on the Roanoke proper; but on the upper Dan and Staunton reservoirs might doubtless be constructed at many points.

The bed of the stream is generally sand below Weldon, with one or two ledges, and the banks are alluvial, not very low as a rule, and in many places lined with overhanging trees; while above Weldon the bed is generally composed of solid rock, sometimes of gravel and sometimes of sand or clay, the banks being alternately high and sometimes bluffy and low and alluvial. Above the falls at Weldon, which extend for a distance of 10 miles above that place, the river is wide, full of rocks and islands in many places, and difficult to navigate in low-water, with large areas of bottom-land subject to overflow in freshets, although the rise is smaller than at Weldon. Some of the low grounds were diked before the war, but the dikes have for a long time received no attention. High dams on the river would, in general, be accompanied by the overflowing of large areas.

* Annual Report of the Chief of Engineers, 1880, p. 803.

† Annual Report of the Chief of Engineers, 1872, p. 726.

‡ Annual Report of the Chief of Engineers, 1876, Appendix G, 9.

The following table will give some idea of the fall of the stream:

Table of declivity—Roanoke river.

Place.	Distance from mouth.	Elevation above tide.	Dist. between points.	Fall between points.	Fall between points.
	Miles.	*Feet.*	*Miles.*	*Feet.*	*Feet per mile.*
Mouth	0	0	120	44	0.36
Weldon	120	44	9	84	9.3
Head of falls	129	128	56	141	2.52
Clarksville	185	269			

In the twenty-second report of the board of public works of Virginia is a report on a survey of the Roanoke, by J. J. Couty. It is there stated that the fall from Rock Landing, in North Carolina, to the confluence of the Dan and Staunton, in Virginia, is 156.65 feet, the distance being 59.9 miles. The same report states that the width of the river is considerable, being even three-fourths of a mile in places, but on the average about 400 yards, and that the bed is mostly of solid rock, and remarkably favorable for dams.

The *water-powers* on the stream will now be described as far as I have been able to obtain information regarding them.

The water-power at Weldon, North Carolina.—The first power on the river as it is ascended is that at Weldon, North Carolina, where the stream crosses the fall-line. The fall here is about 84 feet in a distance of 9 miles above the town, the river within this distance being very rocky and rapid, the channel very tortuous, and the bed of the river interspersed with rocks and islands, most of which are submerged at high water. Some of the larger islands are cultivated. The bed of the river is almost solid rock, and the banks generally abrupt, especially on the upper part, for several miles below the head of the falls, where they are 40 or 50 feet high, of hard granitic rock, and generally extending almost perpendicularly to the water's edge. The river is much narrower here than above the falls. Some fifty years ago the Roanoke Navigation Company extended navigation around these falls by constructing a canal on the south side of the river between Weldon and Rock Landing, 9 miles above. This canal was 30 feet wide at the top and 3 feet deep, dimensions sufficiently large for the boats then in use on the river. The enterprise does not seem to have been a financial success, and, although the company is still in existence, the works have long been allowed to fall into disuse, and the canal is very much filled up with silt and rubbish, being only kept clean to an extent sufficient to enable it to supply the necessary water to run a few small mills, no one but the mill-owners seeming to take any interest in it. It was originally substantially built, and crosses several small creeks by means of stone aqueducts, all of which, as well as some of the locks, which were also of stone, are in good condition, although the gates of the latter are gone; and toward the upper end of the canal there are extensive masonry walls in places on the river side, rendered necessary by the abruptness of the banks, and all in good condition. At the upper end of the canal there was a guard-lock, and probably a dam, but the gates of the lock are gone, and the dam now there consists only of a few stones piled up roughly. The river at this place is said to be very favorable for the construction of a dam which might extend entirely across the river.

Nearly four miles below the head of the canal is a flight of four locks with a total lift of 36 feet.* The fall of the upper two is utilized by a saw- and grist-mill and cotton-gin, using about 18 feet fall, 25 horse-power, and discharging the water to the lower level. This mill can run at full capacity all the time, but little additional power can be obtained without increasing the capacity of the canal above, which is at present only 12 to 15 feet wide and 3 or 4 feet deep. The total fall of these locks, 36 feet, is practically available at this place, and the land in the vicinity is favorable for building.

At the lower end of the canal a fall of 48 feet between the level of the canal and the river was overcome by a flight of 6 locks with 8 feet lift each.* This fall is used by two mills and a foundry; the upper one, a grist- and flour-mill (two run of stones) and two cotton-gins, uses 18 feet fall and 30 or 40 horse-power; the lower one, a corn- and flour-mill (six run of stones), uses the same fall and 70 or 80 horse-power, and the foundry uses the same fall and some 15 or 20 horse-power. All these mills discharge the water directly to the river, and are situated from 100 to 200 yards above the old locks, which are in bad condition. They can run full capacity all the year, except occasionally for a few days at a time, when they have to stop on account of high water. Little additional power, however, can be obtained with the present condition of the canal. There is scarcely any trouble whatever with ice.

Although the fall between the level of the canal at its lower end and the river is 48 feet at low-water, according to the report of the company the freshets of the river are so frequent and so violent that it is not to be considered practically available for manufacturing unless supplementary steam-power be introduced. Just what fall may be economically used depends on various circumstances which cannot be considered here. The land is favorable for building so far as its topography is concerned. The canal is at present somewhat wider on the lower level than on the upper, but is shallower.

* Report of Roanoke Navigation Company in one of the reports of the board of public works of Virginia.

As already mentioned, the canal at Weldon is owned by the Roanoke Navigation Company—a stock company, of which some shares are said to be owned by private individuals and some by the states of Virginia and North Carolina. There being no interest taken in the canal, either as a means of navigating the river or as a means of supplying water-power—it being, in fact, practically abandoned—the mills pay no rent for their water-power. It is said, however, that many years ago some water-power was let at a certain rate per run of stone.

In addition to the power which is utilized along the canal there is a small amount of power used between Weldon and Gaston by mills located directly on the river. Thus, on the north side of the river, there is a grist-mill with a fall of about 7 or 8 feet, running two or three run of stones, and there have been others, at various times, on both sides of the river. On the south side there was a grist-mill, about 1 mile below South Gaston, said to have had a fall of 15 feet, with a race one-half mile long. These mills are, of course, liable to be stopped often during freshets.

The total drainage area of the Roanoke above Gaston, or the head of the falls, is about 8,200 square miles, and the rainfall over this area is about 40 or 42 inches, distributed tolerably evenly throughout the year. I found no records of continued gaugings of the river. Professor Kerr measured the flow at Haskins' Ferry, over 50 miles above Weldon, in the fall, and found it to be 2,950 cubic feet per second, the drainage area above this point being about 7,350 square miles, but the stage of the river is not stated.* I have estimated the flow of the river at Gaston to be as follows (see pages 18 to 21):

	Cubic feet per second.
Minimum flow	1,500
Minimum low-season flow	1,700
Maximum available, with storage	6,000
Low-season flow, dry years	1,950

The corresponding power may be tabulated as follows:

Flow, cubic feet per second.	Horse-power available, gross.			
	1 foot fall.	36 feet fall.	18 feet fall.	84 feet fall.
1,500	170	6,120	3,060	14,280
1,700	193	6,948	3,474	16,212
6,000	680	24,480	12,240	57,120
1,950	221	7,956	3,978	18,564

If the water could be stored during the night, so as to concentrate the total available power into 12 hours, the powers given in the table above would all be doubled, but it would probably be found very difficult and expensive, if not impossible, to do this. The estimates I have given may seem too low, but I have been especially anxious to avoid making them too high, and I believe that they will be found rather under than over the truth. This enormous power, almost totally unutilized, is available, although it would be very expensive to utilize the whole of it. The existing canal, if cleaned out to its original dimensions, would be capable of carrying about 120 cubic feet per second, with a fall of a foot to the mile, and by making the channel *very smooth* it might carry 250 to 300 cubic feet per second with the same dimensions. To enlarge the canal to the dimensions necessary to enable it to carry 1,500 cubic feet per second would, especially in the upper part, be very expensive, and necessitate considerable blasting. The power which would be rendered available if the canal were cleaned out to its original dimensions is shown by the following table, the fall assumed being one foot to the mile. The capacity may be taken to vary between 120 and 250 cubic feet per second, according to the condition of the bed:

Table showing available power at Weldon with existing canal.

Capacity of canal, cubic feet per second.	Horse-power available, gross.			
	1 foot fall.	36 feet fall.	18 feet fall.	84 feet fall.
120	13.64	491.0	245.5	1,145.8
250	28.41	1,022.8	511.4	2,386.4

The power is calculated for the same fall as before, because the fall of the canal itself could be given by a dam at its head. It must be expressly remarked that if the capacity of the canal is to be made 250 cubic feet per second, the bed and slopes must be made very smooth, indeed, by being cemented or lined with boards carefully fitted to each other, and with great care the capacity might, perhaps, be increased above 250 cubic feet per second. If the fall is made 2 feet per mile, the available powers would be nearly 1.4 times as great as those given in the above table. By deepening the canal its capacity might be considerably increased at small cost.

* Maury (Survey of Virginia, pp. 36, 37,) says that the flow of the Roanoke at head of tide-water in dry seasons is *estimated* at 1,350 cubic feet per second.

The powers given in the above table could be rendered available without much difficulty, but it must be remembered that all the power calculated thus far is the gross horse-power, and that the amount to be practically utilized would be less, varying according to the motor employed. With good turbine-wheels the net power will be about three-quarters or eight-tenths of the gross power.

The power at Weldon is one of the largest in the state of North Carolina, and the principal cause of its not being utilized to a greater extent is probably the lack of capital. It is said that the place is not very healthy, and that malaria and chills and fever are prevalent at certain seasons. It is certain that it is not so healthy as the country farther west, but I doubt whether this would be a sufficient ground to prevent the utilization of such a magnificent power. The facilities for transport are excellent, both by land and by water, for the river can be made navigable up to the town, and it is quite a railroad center. Four railroads terminate in the town, viz, the Petersburg railroad, the Seaboard and Roanoke railroad, the Wilmington and Weldon railroad, and the Raleigh and Gaston railroad, thus bringing Weldon within 2½ hours of Petersburg, 3½ hours of Richmond and Portsmouth, 6 hours of Wilmington, and 5 hours of Raleigh.

Good building-stone and timber can be obtained in abundance in the neighborhood, and a good deal of cotton is raised in the vicinity. The iron-deposits near Gaston have only been worked to a very small extent, although the ore is said to be of good quality. The advantages for the utilization of the power are in fact excellent in all respects, and that there are no serious drawbacks is proved conclusively by the successful operation of Mr. Battle's cotton factory at Rocky Mount, on the Tar river, only a few miles distant. The place is worthy of a careful examination by capitalists.

Above Gaston the river widens, and there are no other powers at all comparable with the one just described, although there are some shoals which might advantageously be utilized, alternating with long boatable stretches of smooth water. In regard to these shoals, however, I was only able to obtain a few scattered notes, and on account of their inaccessibility I was unable to visit any of them.

Four miles above Rock Landing, the head of the Weldon canal, is a shoal, around which the Navigation Company constructed a canal 400 yards long, with a lock at the lower end having a lift of 9 feet. The fall at this shoal is said to be utilized, to a small extent, by a grist-mill.

Two miles further up there is a second mill, and above that are several others, tabulated in the table of utilized power. The available fall, however, I am unable to state. The only other place on the river where the Navigation Company found it necessary to construct a canal was at Pugh's falls, where there was one lock with 5½ feet lift,* but I am unable to say just where this place is located. I am also unable to give any information regarding the present condition of these canals, but the probability is that they are in very bad order.

The principal reason why these shoals have not been used more extensively is probably the fact that the river is wide, so that the dams necessary are long and expensive and subject to injury by the freshets. Of necessity, therefore, mills have usually been located on smaller streams.

Finally, it may not be out of place to say a few words regarding the causes of the low flow of the Roanoke (estimated), as compared with that of streams in New England. These causes are probably the following: (1) The rainfall on the drainage-basin is not greater, and probably rather less, than on the basins of New England streams; (2) it is, on the whole, tolerably uniformly distributed throughout the year, but on some parts of the Dan and Staunton rather more falls in winter than in summer; hence, as the evaporation is very large, the streams will be very low in summer, when the evaporation is greatest and the rainfall least; (3) there are no lakes to regulate the flow.

As regards the estimate which I have given for the power available at Weldon, with storage, it is to be remarked that to render this power available would require the construction of storage-reservoirs sufficient to store a rainfall of perhaps 3 inches on the whole water-shed, which would correspond to a storage capacity of over 57,000 millions cubic feet. Such storage would be very expensive, so that, for the present at least, the estimate of power from storage has little interest practically.

TRIBUTARIES OF THE ROANOKE RIVER BELOW THE JUNCTION OF THE DAN AND THE STAUNTON RIVERS.

In regard to these streams very little is to be said. None of them are of any importance, and possess no large water-powers, so far as I could learn. The only power used on them is for running small grist- and saw-mills, the grist-mills generally with one, two, or three run of stones. I visited none of these streams, and the tables of the power utilized on them, compiled from the reports of the enumerators, will show that they are not of much consequence. For small powers they can be economically utilized—more economically than the Roanoke itself—because they have more fall, because the cost of a permanent dam is less, and because the mills are not troubled with high water, as those on the Roanoke are; but their flow is, of course, much more variable than that of the Roanoke.

*Report of Roanoke Navigation Company in one of the reports of the Virginia board of public works.

THE DAN RIVER.

The Dan river, one of the main forks of the Roanoke, rises in Patrick county, Virginia, near Buffalo Knob, in the Blue Ridge. It flows first in a southeasterly direction, enters North Carolina, flows through Stokes and Rockingham counties, and, pursuing a general easterly course, enters Virginia in Pittsylvania, returns to North Carolina in Caswell, and finally enters Virginia again in Halifax, to unite with the Staunton in the adjoining county of Mecklenburg, forming the Roanoke. The length of the stream, measured in a straight line nearly east and west, is about 100 miles, and by the course of the river about 180 miles. The principal towns on the river are Danbury, Madison, and Leaksville, North Carolina (all small towns of several hundred inhabitants); Danville, Virginia, with a population of over 13,000; Milton, North Carolina, and South Boston, Virginia, with five or six hundred inhabitants each.

As has already been stated, the river was many years ago made navigable by the Roanoke Navigation Company as far as Danville, and for 50 or 60 miles beyond. It is now navigable for 60 miles above that place (as far as Sauratown) for bateaux carrying 12,000 pounds, although formerly bateaux sometimes reached Hairston's falls, 12 miles below Danbury. Boats propelled by poles now ply irregularly between Danville and various other points on the river.

The river and harbor act of June 18, 1878, provided for a survey of the river from Clarksville, Virginia, to Danbury, North Carolina, and the reports on this survey by Mr. S. T. Abert, United States civil engineer, are to be found in the reports of the Chief of Engineers, 1879, p. 652, and 1880, p. 794. These reports give detailed information regarding the river, and have been used freely in the present report. By the river and harbor act of June 14, 1880, the sum of $10,000 was appropriated for the improvement of the river between Madison, North Carolina, and Danville, Virginia, "the object being to afford a channel for steam navigation not less than 35 feet wide, and not less than 1½ feet deep in the pools and 2 feet deep in the rapids at extreme low-water," the estimated cost of the work being $52,000.

The total area drained by the Dan is 3,700 square miles. The tables on pages 34, 35, 37, and 38 give the drainage areas above the principal water-powers.

The principal tributaries to the river are, from the north, going up the river, Bannister river, Birch creek, Sandy river, Smith's river, and Mayo river; from the south, going up, Hyco river, County-line creek, Moon's creek, Hogan's creek, and Town fork. These will be referred to again.

The drainage area of the Dan lies principally in the middle division, the sources of the river being on the eastern slope of the Blue Ridge. Its general character does not differ, as a whole, from that of the middle division, which has been described on a previous page. Its shape and dimensions may be seen by referring to the accompanying map. Geologically, it lies in the area of metamorphic rocks. Granite is found at various points; also sandstone, limestone, and slate, and fine building-stone is to be had in abundance. The valley is rich in coal and iron, extensive beds of iron-ore, which have been worked to some extent for more than half a century,* occurring near Danbury, North Carolina. The coal-fields embrace an area of over 30 square miles, and have been developed only to a very small extent. Lying in the immediate vicinity of extensive iron-beds, their importance cannot be overestimated.† Copper also has been found in the valley.

The water-shed separating the valley of the Dan from those of the Yadkin and Cape Fear is a "long and broad ridge or swell of land, which trends due east", with an elevation of 800 feet and upward. The bed of the river is generally 200 or 300, and sometimes 400, feet below the adjacent ridges, and its tributaries have, therefore, very considerable fall, some of them affording very fine water-power.

The principal products of the valley are tobacco, corn, wheat, rye, oats, potatoes, and fruits. There is very little, if any, cotton grown in the valley. "Between Danbury and Leaksville the land appears to be best adapted to tobacco culture, and a fine grade is produced, although there are some short stretches of very good bottom-land. Further down, the valley widens, and broad bottoms are found cultivated in corn and wheat." The country is hilly and undulating, and in the extreme west mountainous. The forests above Danville are extensive and valuable.

There are no lakes in the basin, but artificial storage-reservoirs could probably be located at many points.

The bed of the river is solid rock, overlaid between the rapids with sand and gravel. The facilities for dams are excellent. Above Danville the banks are generally moderately high, and sometimes abrupt and bluffy, and the bottoms narrow and not often overflowed. Below Danville the banks are lower, the bottoms wider, and oftener overflowed, and bluffs more rare. There are no regular ravines of any extent, a bluff on one side of the river being generally faced by shelving or low ground on the other.

The river is subject to heavy floods, the river rising and falling very rapidly. At Madison, in 1850, it rose 28.4 feet; and at Danville, in 1873, 17 feet above ordinary low water. Below Danville the floods rise still higher. Thus, in November, 1877, the river rose to heights of 30.21 feet above low water at Milton; 33.54 feet at Oliver's mill, 28 miles below Danville; and 23.7 feet at Clarksville. Such rises are, however, very rare. There is seldom any trouble with ice, and ice-jams occur very seldom, although the river is sometimes frozen over. "Notwithstanding the height of the floods, the banks are seldom washed, their permanency being secured by a fringe of willow-growth, which borders the low grounds."

* Annual Report Chief of Engineers, 1879, p. 654.

† Dr. Genth (see above source).

The Dan and Staunton rivers, being comparatively not so wide or shallow as the Roanoke, and having fewer bottoms subject to overflow, are considered more favorable for navigation than the latter stream.

The average annual rainfall on the valley of the Dan is about 43 inches, distributed approximately as follows: Spring, 11; summer, 12; autumn, 10; winter, 10. In the upper parts of the valley the rainfall is as follows: Spring, 12; summer, 14; autumn, 10; winter, 14 inches. The following table will show the declivity of the stream:

Table of declivity—Dan river.

Place.	Distance from mouth.	Elevation above tide.	Dist. between points.	Fall between points.	Fall between points.
	Miles.	*Feet.*	*Miles.*	*Feet.*	*Feet per mile.*
Clarksville	0.00	269			
Danville, Richmond and Danville railroad-crossing*	64.27	390	64.27	121	1.88
Madison bridge	114.37	547	50.10	157	3.13
Hairston's ford	129.31	599	14.94	52	3.49
Danbury ford	142.76	694	13.45	95	7.26

* For the elevations on the Richmond and Danville railroad I am indebted to T. M. R. Talcott, general manager, who had special measurements made of the height of the track above the water-surface.

Having no records of gaugings of the Dan river, I am obliged to resort to estimates of the flow. The following estimates are for the mouth of the stream:

Table of estimated flow and power of the Dan River at mouth.

State of flow (see pages 18 to 21).	Drainage area.	Flow per second.	Horse-power available, gross.
	Sq. miles.	*Cubic feet.*	*Per foot fall.*
Minimum	3,700	700	80
Minimum low season	3,700	810	92
Maximum, with storage	3,700	3,000	341
Low season, dry years	3,700	950	108

The Dan river has been thus far not very accessible above Danville. Below that point the Richmond and Danville railroad is within 4 miles of the stream for about 50 miles, after which it leaves the river nearly at right angles. Above Danville the river is for about 30 miles within 6 miles of the railroad, but above that it has been quite inaccessible. Thus the part of the stream which is easily accessible is between the mouth of the Bannister river and the town of Leaksville. Two railroads are now being built, however, which will render that part of the river above Danville as accessible as that below, and will do a great deal to develop the resources of the valley (see page 36).

WATER-POWERS.—It has already been stated that the average fall of the Dan between Clarksville and the Richmond and Danville railroad bridge is 1.88 feet per mile. This fall is, however, not evenly distributed over the whole distance, but is mainly concentrated at a few localities, thus affording fine opportunities for developing large water-powers.

In the table below is given each shoal on the river, but as some are of no importance, and their fall is very small, I do not consider it worth while to make mention of them particularly. I shall therefore mention in this place only the larger shoals, giving such of their characteristics as I have been able to gather from the reports of surveys made under direction of Mr. Abert. The falls given in the table are those of the shoals opposite which they are placed, and the distance of whose foot, from Clarksville, is given in the second column.

Proceeding up the river from Clarksville, the first shoal encountered is *Skipwith's shoal*, one-fourth of a mile above the town. Length of shoal, 6,660 feet; fall, 2.621 feet; rock bottom. Not utilized.

For the next 4 miles the fall is very gentle, and at one place the Staunton river is only 500 feet distant, a portion of the water of the Dan flowing over through what is called Skipwith's Thoroughfare to join the Staunton. About 5 miles from Clarksville is *Nelson's shoal*, a little over a mile long, with a fall of 2.216 feet; rock bottom; not used; river full of rocks, many appearing above the surface.

About 7½ miles above Clarksville is another channel, between the Dan and the Staunton, about 120 feet wide, one-half a mile long, and known as the Upper Thoroughfare. From this point down to their confluence the two rivers are nowhere more than three-fourths of a mile apart. Just above this thoroughfare commences *Marbleyard shoal*, 8,319 feet long; fall, 4.665 feet; rock bottom; not used.

The next shoal of importance is *Little Hyco falls*, a very dangerous shoal for boats, and one which is ascended with difficulty. The most important shoal on this part of the river is *Big Hyco falls*, 13 miles above Clarksville. The bed of the stream consists of a series of rock ledges and projecting rocks, over which the water rushes swiftly. I did not visit this place in person, but I was informed that the bank on one side is bluffy, while on the other a canal could easily be led out, if necessary. Then follow a series of smaller shoals. King's shoal is utilized for a small grist-mill, with an undershot wheel and a wing-dam, and Moon's shoal was formerly so used. It is noticeable that there are several steam saw-mills in this vicinity.

The *Yellow Gravel shoal* is used for power, running a grist-mill on the south side of the river, which is here divided by an island 3,300 feet long into two channels of nearly equal width. From the head of the island a dam extends diagonally across the left channel, having a length of 600 feet, and serving to turn the water into the right channel, on which the mill is situated, some 2,200 feet below, with a second dam 5.8 feet high across this channel. Nine-tenths of the volume of the river, however, pours through a sluice in the dam at the head of the island. The mill is driven by a 6-foot turbine-wheel, operating 3 run of stones, or using perhaps 40 net horse-power.* The river bottom at this shoal is generally gravel, with some rock. For over 7 miles above this place there is no shoal of importance, the next being *Reedy Bottom shoal*—a long shoal, with a pretty uniform slope, and generally a rock bottom.

At *Coldwell's shoal* is one of the dams built by the Roanoke Navigation Company, but the fall is not of importance. There are several saw-mills on the river between this shoal and the previous one, but none of importance.

The next shoal of importance is the *Milton shoal*. The fall is moderate in the upper 4,100 feet, but for the remainder of the length very rapid, and the river is full of islands and rocks. Below the shoal the river is only 120 feet wide for a distance of three-quarters of a mile.

The next shoal of importance is the *Danville shoal*, just below the Richmond and Danville railroad-bridge, and nothing more than a continuation, with a less rapid fall, of Danville falls, yet to be described. The bottom is wholly rock.

In regard to the amount of power which can be utilized on the river between Danville and Clarksville, an opinion could only be formed by a personal examination. From what has been said, it is clear that there would be no difficulty in building dams almost anywhere, so far as the bed of the stream is concerned, and the banks are much more favorable than on the Roanoke; but whether much of the fall is available for power, at reasonable cost, I cannot say. In the table are given estimates of the power at only a few points, but at the end are added estimates of the total theoretical powers between those particular points, but which are, probably, not practically available. The powers given for the separate shoals are for the natural fall in the river at each shoal, and may, of course, be increased if that fall is increased by a dam.

Summary of power, etc., of the Dan River between Clarksville and Danville.

Locality.	Distance from Clarksville.	Drainage area.	Rainfall.					Total fall.		Horse-power available, gross.†				Total utilized.		Remarks.
			Spring.	Summer.	Autumn.	Winter.	Year.	Height.	Length.	Minimum.	Minimum low season.	Maximum, with storage.	Low season, dry years.	Fall.	Horse-power, net.	
	Miles.	*Sq. miles.*	*In.*	*In.*	*In.*	*In.*	*In.*	*Feet.*	*Feet.*					*Feet.*		
Skipwith's shoal	0.23	3,700	11	12	10	10	43	2.621	6,000	210	240	890	280	......	......	Rock bed.
Nelson's shoal	5.18	3,700	11	12	10	10	43	2.216	5,505	......	......	......	......	......	......	Do.
Jericho shoal	7.00	3,700	11	12	10	10	43	0.905	1,210	......	......	......	......	......	......	Do.
Marbleyard shoal	7.71	3,690	11	12	10	10	43	4.665	8,319	375	425	1,575	500	......	......	Do.
Hog island shoal	9.48	*3,680	11	12	10	10	43	1.261	882	......	......	......	......	......	......	Do.
Island creek shoal	9.93	*3,670	11	12	10	10	43	2.390	3,294	......	......	......	......	......	......	Do.
Bagby's shoal	10.65	*3,610	11	12	10	10	43	0.771	1,854	......	......	......	......	......	......	Do.
Hyco shoal	11.23	*3,600	11	12	10	10	43	1.957	3,560	......	......	......	......	......	......	Do.
Little Hyco falls	12.09	*3,600	11	12	10	10	43	3.100	1,510	240	275	1,075	315	......	......	Do.
Big Hyco falls	12.82	3,190	11	12	10	10	43	9.382	3,153	610	750	3,000	850	......	......	Do.
King's shoal	14.69	*3,180	11	12	10	10	43	2.670	4,482	......	......	......	......	2	20	Rock and gravel bed.
Grassy creek shoal	17.61	*2,670	11	12	10	10	43	1.478	2,926	......	......	......	......	......	......	Rock bed.
Moon's shoal	19.93	*2,650	12	12	10	11	45	2.331	1,406	......	......	......	......	......	......	Do.
Boston shoal	23.15	*2,620	12	12	10	11	45	2.131	2,858	......	......	......	......	......	......	Do.
Yellow Gravel shoal	28.20	*2,580	12	12	10	11	45	3.644	4,068	190	230	500	265	5	15	Drift, rock, and gravel bed.
Chappell's fish-trap	32.08	*2,540	12	12	10	11	45	0.986	280	......	......	......	......	......	......	Fish dam.
Lawson's shoal	33.08	*2,520	12	12	10	11	45	1.087	2,886	......	......	......	......	......	......	Drift and sand bed.
Reedy Bottom shoal	34.20	2,485	12	12	10	11	45	5.223	11,338	265	320	1,250	365	......	......	Rock, gravel and sand bed.

* Interpolated. † See pages 18 to 21.

* The flow of the stream was measured by Mr. J. H. Gill, U. S. assistant engineer, just below this place, "at low-water," and found to be 990 cubic feet per second.

Summary of power, etc., of Dan River—Continued.

Locality.	Distance from Clarksville.	Drainage area.	Rainfall. Spring.	Rainfall. Summer.	Rainfall. Autumn.	Rainfall. Winter.	Rainfall. Year.	Total fall. Height.	Total fall. Length.	Horse-power available, gross.† Minimum.	Minimum low season.	Maximum, with storage.	Low season, dry years.	Total utilized. Fall.	Horse-power, net.	Remarks.
	Miles.	*Sq. miles.*	*In.*	*In.*	*In.*	*In.*	*In.*	*Feet.*	*Feet.*					*Feet.*		
Powell's shoal	37.77	*2,460	12	12	10	11	45	1.241	4,478	......	......	......	......	......	......	Rock and sand.
Coldwell's shoal	43.52	*2,420	12	12	10	11	45	1.646	2,738	......	......	......	......	......	......	Gravel and rock.
Milton shoal	50.05	2,286	12	12	10	11	45	7.138	6,898	330	400	1,600	460	......	......	Rock.
Dodson's shoal	51.61	*2,270	12	12	10	11	45	2.384	1,204	......	......	......	......	......	......	Do.
Crowder's shoal	54.05	*2,240	12	12	10	11	45	1.879	3,290	......	......	......	......	......	......	Do.
Rattlesnake shoal	55.78	*2,230	12	12	10	11	45	1.174	3,202	......	......	......	......	......	......	Do.
Wilkinson's shoal	58.41	*2,200	12	12	10	11	45	0.979	720	......	......	......	......	......	......	Do.
Pass' shoal	58.80	*2,140	12	12	10	11	45	0.679	700	......	......	......	......	......	......	Do.
Dix's shoal	59.27	*2,130	12	12	10	11	45	1.714	282	......	......	......	......	......	......	Gravel.
Noble's shoal	60.38	*2,010	12	12	10	11	45	2.173	2,052	......	......	......	......	......	......	Rock.
Allen's shoal	61.28	*2,000	12	12	10	11	45	0.665	884	......	......	......	......	......	......	Do.
Jack Bar shoal	62.09	*1,990	12	13	10	12	47	1.890	854	......	......	......	......	......	......	Gravel.
Wilson's island shoal	62.27	*1,990	12	13	10	12	47	2.185	2,280	......	......	......	......	......	......	Rock.
Danville shoal	62.69	1,989	12	13	10	12	47	10.668	8,375	430	500	2,100	570	......	......	Do.
Richmond and Danville railroad bridge.	64.27	1,989	12	13	10	12	47	......	......	......	......	......	......	......	......	
									Miles.							
Between head of Skipwith's shoal and foot of Marbleyard shoal	1.49 7.71	3,700 3,690	11	12	10	10	43	6.452	6.22	515	590	2,200	675	......	......	
Between head of Marbleyard shoal and foot of Little Hyco shoal	9.29 12.09	3,690 3,600	11	12	10	10	43	7.272	2.80	565	650	2,550	740	......	......	
Between head of Big Hyco shoal and foot of Yellow Gravel shoal	13.42 28.20	3,190 2,580	12	12	10	11	45	15.274	14.78	820	990	3,950	1,130	......	......	
Between head of Yellow Gravel shoal and foot of Reedy Bottom shoal	28.96 34.20	2,580 2,485	12	12	10	11	45	6.076	5.24	315	385	1,500	440	......	......	
Between head of Reedy Bottom shoal and foot of Milton shoal	36.34 50.05	2,485 2,286	12	12	10	11	45	14.735	13.71	720	880	3,500	1,000	......	......	
Between head of Milton shoal and foot of Danville shoal	51.36 62.69	2,286 1,989	12	12	10	11	45	24.117	11.33	1,050	1,280	5,150	1,460	......	......	
Total on Dan river up to head of Danville shoal.	64.04	3,700 1,989	11	12	10	10	43	120.806	64.04	6,635	7,915	31,290	9,050	......	......	

*Interpolated. † See pages 18 to 21.

The next power above the Danville shoal is at *Danville falls*, at the city of Danville, Virginia. The total fall here is 21.977 feet, in a distance of 7,425 feet, between the Richmond and Danville railroad-bridge and a point 2,000 feet above the existing dam. The town of Danville is situated on the south side of the river, and on the opposite side is the village of North Danville. The bed of the stream is of solid rock, covered in places with sand and gravel, and the banks are shelving on the south side, offering good building-sites, while on the north side they are more abrupt and less favorable; and along this bank runs, for a short distance, the Virginia Midland railroad, which terminates at the Richmond and Danville railroad-bridge. Around these falls the Roanoke Navigation Company constructed a canal, on the south side of the river, about 3,200 feet long, 30 feet wide, and probably originally about 3 feet deep, with three locks at the lower end, having a total lift of 20½ feet, and a guard-lock at the head with a lift of 7 feet.* The locks are out of repair, and no attempt is made to keep them in order, this canal having passed into the hands of private individuals, and being used only to supply water-power. It is said that none of the canals on the Roanoke or Dan rivers, except the one at Weldon, are now owned by the Navigation Company. The upper gate of the lower locks is kept closed to keep the water level up, and although boats enter the canal from above there is no egress below. At the head of the canal is a dam built of wood and stone—the wooden frame being bolted down to the rock with iron pins—extending in a broken line diagonally up stream, with a length of about 700 feet and a height of about 4 feet. The river here is about 1,100 feet wide, and the dam extends rather beyond the center. It was built about the year 1830, but the principal part was rebuilt in 1873 and 1874, and cost about $8 per running foot. It is founded entirely on solid rock, and, although once a little injured by a freshet, there is rarely any trouble with either freshets or ice. The pond is, of course, insignificant. The canal, although probably originally 3 feet deep, is at present much filled up in some places, its depth varying from 1.9 to 3.5 feet, and supplies power to the following mills, taking them in order down the canal:

1st. Gerst's planing-mill. A new mill is now being put up, and the old one is not running. They have a fall of 7 or 8 feet, and own the right to 50 horse-power, but no care is taken by those owning the power to regulate strictly the quantity of water they consume. They can run at their full capacity for about seven months, and sometimes can only get half capacity.

* Report of Roanoke Navigation Company in one of the reports of the board of public works of Virginia.

2d. Foundry and machine-shop, owned by Crews & Rodenhizer, and rented by Corbin & Westbrook. They only run two or three days of the week, use 9-feet fall and 30 horse-power, and say that they can get full capacity all the time. They use an overshot wheel, and the amount of water is not strictly regulated.

3d. G. W. Yarbrough's grist-mill, running two sets of stones, with 17 feet fall and some 25 horse-power. Full capacity can be obtained during nine months, and sometimes only one-half can be obtained. Mill and power is rented at a fixed price per annum, and as much water can be used as can be obtained, for here, as in the other cases, no attempt is made to regulate the amount. The water-power on this side of the river is owned by the firm of Crews & Rodenhizer.

These mills have no trouble with ice, and the upper one has none with backwater, but the lower two are troubled for perhaps two days in the year from that cause. All these mills could get full capacity all the time if the canal were properly cleaned out.

The power on the north side of the river is owned by Lee, Hatcher & Co., and is used for a corn- and grist-mill and a foundry and machine-shop. The dam, which is built partly of wood and partly of stone, extends, in a broken line, very obliquely up stream below the dam on the south side, and not reaching the center of the stream. The stone part extends from the bank for a distance of 400 feet, was built in 1874 at a cost of $5,000, and has an average height of 4 feet; while the wooden part, a continuation of the stone part, has a length of 600 feet, a height of 4 feet, and was built in 1876 at a cost of $2,000, being constructed of crib-work, fastened to the rock with iron pins, and filled with stone. The bed is solid rock. The mills are situated at the base of the dam, using a fall of 8 feet 2 inches, and about 80 horse-power, the tail-race being blasted out of the solid rock for some distance. The dam simply intercepts what water flows around the end of the Danville dam, and, of course, gives no storage. The owners claim 200 horse-power available with the fall mentioned, and expect to get full capacity all the time. (The improvements were in progress at the time of my visit.) The flour-mill has 4 sets of stones, and will run night and day, and the machine-shop 10 hours. Three turbine-wheels supply the power. The dam has never been carried away or injured by freshets. Mr. Hatcher states that, with a 5-foot dam further up the river, a fall of between 16 and 17 feet can be rendered available in a distance of 2,500 feet; and the firm indicated their intention of developing the power to a large extent in this way, and of leasing water at a fixed rate per day per horse-power.

The city of Danville obtains its water-supply by pumping water from the river at a point about 1½ miles above the dams. The present supply amounts to 2,000,000 gallons per week, but is expected to be 5,000,000 in a few years, as the water-works are new. This amount, however—less than 2 cubic feet per second—is insignificant as a source of loss of power below.

The width of the river opposite Danville varies from 1,100 feet, at the head of the falls, to 850 feet at other points. Between Danville and Milton shoal it is from 240 to 640 feet, or an average of 280 feet; at Milton shoal it is from 240 to 440 feet; from Milton shoal to Hyco shoal it is from 210 to 540 feet, or an average of 300 feet, and below Hyco shoal it is from 250 to 530 feet, or an average of 340 feet.

The area drained by the Dan above Danville is about 1,989 square miles, and the rainfall about 42 to 46 inches, with 13 inches in summer and 12 inches in winter (see table on page 37). In the absence of any gaugings of the flow, I have estimated it, and the power, as in the following table:

Estimate of flow of stream, and of the power, at Danville, Virginia.

State of flow (see pages 18 to 21).	Drainage area.	Fall.	Flow per second.	Horse-power available, gross.	
	Square miles.	*Feet.*	*Cubic feet.*	*1 foot fall.*	*22 foot fall.*
Minimum	1,984	21.977	360	40.7	900
Minimum, low season			420	47.4	1,150
Maximum with storage			1,750	199.0	4,375
Low season, dry years			475	54.0	1,188

The full power at Danville has never been utilized. The present canal, if cleared out to its original dimensions (30 feet wide at top and 3 feet deep), would, as in the case of the Weldon canal, carry from 120 to 250 cubic feet per second, but in this case it would not be difficult to make its capacity sufficient to carry the whole flow of the river.

The question of the purchase by the city of Danville of the entire water-power of the Dan river at this place has been agitated recently.

Although the valley of the Dan above Danville offers sites for storage-reservoirs, yet it would, perhaps, be difficult to obtain sufficient storage to render the maximum power available.

The location of Danville, as regards transportation, is most favorable, situated as it is on the Richmond and Danville railroad, and on the Virginia Midland. Several new roads have been projected, and two are being built (or have been surveyed and located) up the valley of the Dan. One of them, the North Carolina Midland railroad, is to run from Danville through Madison, thence southward to Statesville and further. The termini of the other road I cannot state, but I understand that it is to run from Danville up the valley of the Dan. The staple product in this neighborhood is tobacco, and the people have not turned their attention to manufacturing, except to a very small extent. The neighboring region is very salubrious, and there seems to be no reason why the water-power of the river should not be more extensively used.

Proceeding up the river, various shoals are encountered, all of which are mentioned in the following table. As before, the power has been calculated only for the principal ones. I am unable to describe in detail any of these shoals, not having visited any of them in person. It is evident, however, that the facilities for power are good, as far as bed and banks are concerned, both from Mr. Albert's report and from what additional information I could gather. The width of the stream between Danville and Madison varies from 190 to 430 feet, averaging perhaps 250 feet. At Hairston's ford, above Madison, it is 160, and at Danbury 120 feet. The power of the river is utilized between Danville and Danbury at only two points, viz, at Eagle falls and at Hairston's falls, and there only by small grist- and saw-mills, using a very small amount of power. The mill at Hairston falls is supplied by a dam at the head of the falls, extending in the form of a V across the stream, with the apex up stream, and constructed of logs. It was built in 1879, at a cost of about $125, and is about 150 yards (?) long and 3½ feet high, backing the water about half a mile. A race about 2,000 feet long leads to the mill, located on the right bank, where a fall of 9 feet is used with a primitive wheel to drive the grist- and saw-mill, some 20 horse-power (net) being utilized, and in dry weather no water flowing over the dam. The bed of the river is solid rock.

A power just above Danbury was formerly used to a small extent by the iron-works at that place. The dam was 10 feet high, and the water carried to the works through a tunnel about 100 yards long, cutting through a spur of the hills around which the river bends, and affording at the lower end of the canal a fall of 21 feet. The fall used by the works was about 16 feet, and the distance from the head of the canal to the foot of the tail-race about half a mile by the river. A very small proportion of the dry-weather flow of the stream was utilized. The works have not been in operation since 1865, and the dam has been entirely washed away. It is said that a dam 18 feet high could be built at this place, in which case the available fall, at the lower end of the canal, would be 29 feet.

Above Danbury the Dan is a small stream, but has a great deal of power, on account of its rapid fall. I can form no estimate of its available power, but it is safe to say that sites for small mills can be found at numerous points all the way up. The utilized power is tabulated below.

The results in the tables below must only be considered as very rough approximations, but I believe the powers given to be rather too small than too great. When it is remembered that the rainfall records for the region considered are very incomplete indeed, so that its distribution through the year is very uncertain, and that there are no gaugings of the river in existence, the engineer will be inclined to put little reliance on the figures given, and I must be distinctly understood as not claiming for them any more value than they are worth. A more accurate knowledge of the climatic and other features of the region considered would doubtless lead me to alter my estimates. And finally, it is to be remarked that these figures refer to the power available with the natural fall of the stream, with its natural flow; or, in the case of storage-reservoirs, with its mean flow at all hours. If the water could be stored during the night, all these powers could be doubled, and the power at many shoals could doubtless be considerably increased by putting up dams.

I have not considered it worth while, however, to calculate the theoretical available power between the principal shoals, as it is uncertain how much of it would be practically available. It is evident that the Dan river offers a large amount of available power and fine facilities for manufacturing.

Summary of power of the Dan River between Danville, Va., and Danbury, N. C.*

Locality.	Distance from Danville.	Drainage area.	Rainfall.					Total fall.		Horse-power available, gross.†				Total utilized.		Per cent. of minimum utilized.
			Spring.	Summer.	Autumn.	Winter.	Year.	Height.	Length.	Minimum.	Minimum low season.	Maximum, with storage.	Low season, dry years.	Fall.	Horse-power, net.	
	Miles.	*Sq. ms.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Feet.*	*Feet.*					*Feet.*		
Richmond and Danville railroad-bridge	0.000	1,989	11–12	12–13	10–11	11–12	44–48	......	......	......	......	......	......	......	......	......
Danville falls	0.500	1,989	11–12	12–13	10–11	11–12	44–48	22.00	7,500	900	1,050	4,375	1,185	8–17	180	2.28
Lynch's shoal	3.232	......	11–12	12–13	10–11	11–12	44–48	2.53	2,531	......	......	......	......	......	......	......
Long shoal	4.583	1,851	11–12	12–13	10–11	11–12	44–48	18.73	8,527	670	835	3,465	944	......	......	......
Glass' shoal	7.789	‡1,810	11–12	12–13	10–11	11–12	44–48	5.68	6,228	200	240	1,025	275	......	......	......
Butter spring shoal	9.299	......	11–12	12–13	10–11	11–12	44–48	2.78	2,420	......	......	......	......	......	......	......
Wolf island shoal	10.606	......	11–12	12–13	10–11	11–12	44–48	2.76	3,508	......	......	......	......	......	......	......
Adams' island shoal	11.986	‡1,760	11–12	12–13	10–11	11–12	44–48	4.38	4,144	150	184	770	210	......	......	......
Adams' fish-trap shoal	13.057	......	11–12	12–13	10–11	11–12	44–48	0.81	532	......	......	......	......	......	......	......
Little Island Ledge rapid	13.263	......	11–12	12–13	10–11	11–12	44–48	0.50	619	......	......	......	......	......	......	......

*Bottom rock; often at surface, always at small depth. All favorable for dams. †See pages 18 to 21. ‡Interpolated.

Summary of power of the Dan river, etc.—Continued.

Locality.	Distance from Danville.	Drainage area.	Rainfall.					Total fall.		Horse-power available, gross.*				Total utilized.		Per cent. of minimum utilized.
			Spring.	Summer.	Autumn.	Winter.	Year.	Height.	Length.	Minimum.	Minimum low season.	Maximum, with storage.	Low season, dry years.	Fall.	Horse-power, net.	
	Miles.	*Sq. ms.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Feet.*	*Feet.*					*Feet.*		
Ware's shore	14.468	†1,735	11–12	12–13	10–11	11–12	44–48	4.35	3,794	145	180	750	205	......	......	......
Pruitt's lower shoal	15.612	......	11–12	12–13	10–11	11–12	44–48	0.37	631	......	......	......	......	......	......	......
Pruitt's upper shoal	15.708	......	11–12	12–13	10–11	11–12	44–48	0.35	657	......	......	......	......	......	......	......
Cow Ford shoal	16.394	......	11–12	12–13	10–11	11–12	44–48	0.23	689	......	......	......	......	......	......	......
Hairston's fish-trap shoal	19.094	......	11–12	12–13	10–11	11–12	44–48	0.42	550	......	......	......	......	......	......	......
Beasley's Gallows shoal	19.891	......	11–12	12–13	10–11	11–12	44–48	0.60	595	......	......	......	......	......	......	......
Tan Yard shoal	20.452	†1,675	11–12	12–13	10–11	11–12	44–48	5.28	4,390	170	211	880	241	......	......	......
Devil's Jump shoal	21.597	......	11–12	12–13	10–11	11–12	44–48	0.37	658	......	......	......	......	......	......	......
Wide Mouth shoal	23.349	......	11–12	12–13	10–11	11–12	44–48	2.17	31	......	......	......	......	......	......	......
Indian shoal	26.946	......	11–12	12–13	10–11	11–12	44–48	0.64	890	......	......	......	......	......	......	......
Sauratown ford shoal	27.54	......	11–12	12–13	10–11	11–12	44–48	0.71	901	......	......	......	......	......	......	......
Double shoal	27.835	1,639	11–12	12–13	10–11	11–12	44–48	5.85	8,619	185	228	950	260	......	......	......
Hamblin's island shoal	33.473	......	11–12	12–13	10–11	11–12	44 48	0.30	400	......	......	......	......	......	......	......
Galloway's fish-trap shoal	33.843	975	11–12	12–13	10–11	11–12	44–48	4.50	2,898	75	100	440	115	......	......	......
Galloway's island	35.536	......	11–12	12–13	10–11	11–12	44–48	0.49	1,500	......	......	......	......	......	......	......
Reese's rock shoal	37.420	†950	11–12	12–13	10–11	11–12	44–48	2.82	2,600	......	......	......	......	......	......	......
Eagle Falls	39.378	†940	11–12	12–13	10–11	11–12	44–48	3.14	1,290	......	......	......	......	......	......	......
Mulberry island shoal	43.100	......	11–12	12–13	10–11	11–12	44–48	1.38	1,250	......	......	......	......	......	......	......
Three islands shoal	45.740	......	11–12	12–13	10–11	11–12	44–48	1.62	883	......	......	......	......	......	......	......
Lone island shoal	46.240	......	11–12	12–13	10–11	11–12	44–48	1.93	1,450	......	......	......	......	......	......	......
Gravel bar	......	......	11–12	12–13	10–11	11–12	44–48	0.04	150	......	......	......	......	......	......	......
Slink shoal	48.30	......	11–12	12–13	10–11	11–12	44–48	2.58	1,074	......	......	......	......	......	......	......
Cross Rock rapid	48.60	......	11–12	12–13	10–11	11–12	44–48	0.69	150	......	......	......	......	......	......	......
Roberson's fish-trap	48.90	......	11–12	12–13	10–11	11–12	44–48	0.30	580	......	......	......	......	......	......	......
Gravel shoal	49.53	......	11–12	12–13	10–11	11–12	44–48	0.38	750	......	......	......	......	......	......	......
Gravel shoal	50.33	......	12	13	10	12	47	0.40	300	......	......	......	......	......	......	......
Beaver island shoal	51.67	......	12	13	10	12	47	2.44	1,090	......	......	......	......	......	......	......
Wolf shoal	52.57	......	12	13	10	12	47	1.20	305	......	......	......	......	......	......	......
Cross Rock shoal	53.70	......	12	13	10	12	47	2.36	1,188	......	......	......	......	......	......	......
Shoal and fish dam	54.39	......	12	13	10	12	47	1.17	381	......	......	......	......	......	......	......
Sandy island shoal	55.21	560	12	13	10	12	47	3.51	3,241	31	44	196	50	......	......	......
Carter's shoal	56.52	550	12	13	10	12	47	4.70	3,276	42	60	260	69	......	......	......
Rutley's shoal	57.56	......	12	13	10	12	47	2.09	1,288	......	......	......	......	......	......	......
Buzzard island shoal	58.40	......	12	13	10	12	47	0.52	220	......	......	......	......	......	......	......
Ladd's ford shoal	59.63	......	12	13	10	12	47	1.18	444	......	......	......	......	......	......	......
Dalton's fish-trap shoal	60.77	......	12	13	10	12	47	2.59	606	......	......	......	......	......	......	......
Granny Angel's shoal	61.44	......	12	13	10	12	47	1.33	441	......	......	......	......	......	......	......
Shoe-buckle island shoal	61.79	......	12	13	10	12	47	2.56	1,806	......	......	......	......	......	......	......
Clay's island shoal	64.21	......	12	13	10	12	47	1.40	477	......	......	......	......	......	......	......
Fish-trap shoal	65.70	†340	12	13	10	12	47	3.93	1,517	18	26	134	30	......	......	......
Hairston's Falls	66.88 68.49	328 †320	12 12	13 13	10 10	12 12	47 47	14.89 6.05	2,629 3,280	66 30	98 44	492 213	110 50	....	....	....
Big Rock shoal	69.91	†315	12	13	10	12	47	8.67	4,033	38	57	270	65	......	......	......
Mount Horrible shoal	71.26	......	12	13	10	12	47	1.85	1,119	......	......	......	......	......	......	......
Williams' fish-trap shoal	71.64	......	12	13	10	12	47	1.79	390	......	......	......	......	......	......	......
Davis shoal	71.82	......	12	13	10	12	47	1.01	205	......	......	......	......	......	......	......
Cow ford shoal	72.21	†312	12	13	10	12	47	4.52	1,841	19	28	140	32	......	......	......
Ducking shoal	73.08	312	12	13	10	12	47	6.44	2,616	27	40	200	46	......	......	......
Fulcher's shoal	73.65	......	12	13	10	12	47	2.01	810	......	......	......	......	......	......	......
Sink hole shoal	74.20	......	12	13	10	12	47	1.13	1,266	......	......	......	......	......	......	......
Red shoal	74.58	†275	12	13	10	12	47	4.79	2,237	18	25	132	29	......	......	......
Old mill shoal	75.20	270	12	13	10	12	47	6.22	3,317	22	32	170	37	......	......	......
Danbury shoal	77.49	250	12	13	10	12	47	10.60	......	37	55	265	68	......	......	......
Old Iron Works shoal	......	250	12	13	10	12	47	21.00 20.00	....	75 102	110 150	525 725	125 175	....	....	....
									Miles.							
Between Danville and mouth of Smith's river	0 28	1,989 1,639	12	13	10	12	47	100.0	28	3,480	4,300	18,000	4,900	......	......	......
Bet. mouth of Smith's river and mouth of Mayo	28 49	1,039 900	12	13	10	12	47	56.0	21	950	1,275	5,600	1,450	......	......	......
Between mouth of Mayo and Danbury	49 78	580 250	12	13	10	12	47	150.0	29	930	1,350	6,250	1,550	......	......	......
Total between Danville and Danbury	0 78	1,989 250	12	13	10	12	47	306.0	78	5,360	6,925	29,850	7,900	......	......	......

*See pages 18 to 21. †Interpolated.

TRIBUTARIES OF THE DAN RIVER.

The first tributary of any importance above the confluence of the Dan and Staunton is Hyco river, which enters from the south, its mouth being just above the head of Little Hyco falls. This stream rises in the extreme southern part of Caswell and Person counties, North Carolina, and flows in a northeasterly direction through Halifax county, Virginia, having a total length, in a straight line, of about 45 miles, and draining an area of about 400 square miles. It is about 125 feet wide near its mouth. Its tributaries are small and unimportant, and there are no important towns on the stream. I was unable to learn much about its power. The bed and banks are said to be everywhere favorable, the former being generally rock. The only power used on the stream is for small grist- and saw-mills, none of which are extensive. No sites not used were brought to my notice, but probably numerous ones may be obtained by damming. As the stream flows parallel to the general strike of the rock strata, it is probable that the declivity is quite uniform and not broken by falls. In another table will be found the total amount of power utilized, compiled from the enumerator's reports. The rainfall on the drainage area being about 40 or 42 inches, I have estimated the flow of the stream at its mouth (see pages 18 to 21) as follows:

	Cubic feet per second.	Horse-power per foot fall.
Minimum	45	5.0
Minimum low season	64	7.3
Low season, dry years	73	8.3
Maximum, with storage	325	37.0

The next tributary of importance is the Bannister river, from the north, rising in Pittsylvania county, Virginia, and flowing a little south of east through Pittsylvania and Halifax, and joining the Dan just above King's shoal, its total length, in a straight line, being about 40 miles, its drainage area about 500 square miles, and its width near its mouth about 120 feet. It flows close by Meadsville and Halifax C. H., which are the principal towns on the stream. It has considerable fall, but is utilized only for small grist- and saw-mills, and a foundry at Meadsville. The power at this latter place is said to be fine, running, besides the foundry, a grist-mill and saw-mill; but I have not been able to obtain details regarding it. Near Riceville, Pittsylvania county, is a power with a fall of 12 feet in 900, with good sites for building on the north bank.* This power is now used by a merchant mill. I have estimated the flow and power of the stream at several points, and the results are as follows (the rainfall being in the neighborhood of 40 inches):

Place.	Drainage area.	Flow per second (see pages 18 to 21).				Horse-power per foot fall.			
		Minimum.	Minimum low season.	Maximum, with storage.	Low season, dry year.	Minimum.	Minimum low season.	Maximum, with storage.	Low season, dry year.
	Sq. miles.	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*				
Mouth	500	60	80	400	91	6.9	9.1	45.4	10.3
Halifax	440	53	71	352	81	6.0	8.0	40.0	9.2
Meadsville	400	48	64	320	73	5.4	7.3	36.4	8.3
Riceville	246	27	37	197	42	3.1	4.2	22.4	4.8

This stream, flowing across the rock strata at large angles with their strike, like the Dan, is probably broken by rapids at various points, but no detailed information could be obtained regarding them. The elevation of the stream at the crossing of the Virginia Midland railroad near Competition, about 32 miles from its mouth, is 585 feet, and at the crossing of the Richmond and Danville railroad at Terry's bridge, some 3 miles from its mouth, it is 304 feet, giving a fall between these points of about 280 feet in a distance of, say, 30 miles, or over 9 feet to the mile—a large fall. As the distance between the two points where elevations are given above was measured from the map, and as the stream is quite crooked, the fall per mile above given is, no doubt, to some extent incorrect; but it is evident that this stream has a very large fall, and it is almost certain that very fine sites for power may be found upon it. Taking the flow at Meadsville as the average in the distance referred to, the fall of 280 feet between the Virginia Midland railroad and the mouth of the river would correspond to power as follows:

	Horse-power.
Minimum	1,512
Minimum low season	2,044
Maximum, with storage	10,192
Low season, dry years	2,324

The next tributary worth mentioning is Country-line creek, from the south, rising in Caswell county, North Carolina, and joining the Dan just on the state-line (hence the name of the stream), after flowing in a northeasterly direction for a distance of about 25 miles in a straight line and draining an area of some 130 square miles. This stream, like the others in this neighborhood, is used only for running small saw- and grist-mills. The fall is considerable, but no great falls at any one place were spoken of, and probably do not exist, as the stream flows

* Information from H. Eaton Coleman, civil and topographical engineer, county surveyor of Pittsylvania county.

nearly parallel to the strike of the rocks. The declivity is probably quite uniform, and the powers obtained only by damming. I heard of no good sites unoccupied. Near the mouth of the stream is Yarbrough's grist- and saw-mill, with a dam of wood and stone 125 feet long and 9 feet high, backing the water 1½ miles, with an average width of 100 feet. A fall of 8 feet at the mill affords a power of some 25 horse-power most of the time, but the flow of the stream is quite variable. Opposite Yanceyville the stream is considerably smaller, and will only afford about 2 or 2½ horse-power per foot fall (gross) during eight months of the year. The water-power of the stream is thus not very extensive.

The other tributaries below Danville—Moon's creek, emptying just above Wilkinson's shoal, and draining about 57 square miles, and Hogan's creek, emptying at Dix's shoal, and draining about 114 square miles—are similar in character to Hyco and Country-line creeks, and are utilized, like them, only to run small country grist- and saw-mills, the former with one or two run of stones. In a later table will be found the statement of the power used on these streams collectively, and more need not be said here.

The mills in this neighborhood are very little troubled by ice, and rarely have to stop on that account. The dams are generally of wood or of crib-work filled with stone, and there is no trouble in obtaining good foundations.

The first tributary above Danville worth mentioning is Sandy river, from the north, lying entirely within Pittsylvania county, Virginia, and emptying 1 mile above Danville. It has several grist- and saw-mills, with two or three run of stones, but no powers of importance. There is said to be a fine site for a storage-reservoir not far from the mouth.

Passing by several small creeks, the next tributary is Smith's river, from the north, a very considerable stream. Rising in the Blue Ridge, in the northern part of Patrick county, Virginia, it flows first nearly east, and, after forming for a few miles the boundary between Patrick and Franklin counties, it enters Henry county, flows through it in a southeasterly direction, and empties into the Dan, in North Carolina, just below the town of Leaksville. The distance from its source to its mouth, in a straight line, is about 36 miles, but by the river it is probably at least twice that distance. The stream flows near to Martinsville, the county seat of Henry county, it and Leaksville being the only towns of importance on the river. The total drainage area of the stream is about 600 square miles, of which 39 are in North Carolina. The drainage area above Martinsville is 330 square miles. Not having visited the river in person, on account of its inaccessibility, I am unable to describe its drainage basin very much in detail. From all that I could learn, however, it is well wooded, with a fertile soil, and abundance of fine building-stone to be had in many places, and with facilities for artificial storage, although there are no lakes. The stream has a very rapid fall, a rock bottom almost everywhere, banks of moderate height, and few low grounds subject to overflow, although it is subject to freshets, during which the water rises 20 feet in places. It is fed to a considerable extent by constant springs, and is said not to be very variable in flow; and the extensive forests are a favorable feature in this respect.

The data regarding rainfall in the basin are very incomplete, but, according to the Smithsonian charts, it may be assumed at about 44 to 48 inches, of which 12 fall in spring, 12 in summer, 10 in autumn, and 12 in winter. I have no records of continued gaugings of the stream, or of its elevations at different points.

The stream is at present not very accessible, the nearest railroad point being Reidsville, on the Richmond and Danville railroad, 14 miles from the mouth of the river. I have, however, already referred to the fact that two roads are now being built, both traversing the valley of the Dan, which will render the lower part of the stream quite accessible.

The upper parts of the river are most accessible from Rocky Mount, the county seat of Franklin county, which is connected with the Virginia Midland railroad by a branch road.

Only a small fraction of the available power on Smith's river is at present used, and with the exception of the cotton and woolen factory of J. T. Morehead & Co., near Leaksville, the only mills are country saw- and grist-mills. The Leaksville power is the only one regarding which I have detailed information, and regarding the others I must refer to the table on page 48, compiled from the reports of the enumerators.

Major Morehead's factory is located about 1 mile from the mouth of the stream, and on its west bank. The dam extends in a broken line entirely across the river, which is here about 500 or 600 feet wide, and is built partly of rubble-work in cement and partly of wood. The stone part is about 180 feet long, 13 feet high, 6½ feet thick, and was built in 1872 at a cost of $4,000, while the wooden part is built of logs, pinned to the bottom, and about 3 feet high. By extending the rock dam across the river all the water in the stream could be turned into the canal. The pond is very small, and gives no storage. A race four-fifths of a mile in length leads to the factory buildings, where a fall of 36 feet is used, and about 300 horse-power is distributed as follows among the different mills: Cotton factory, 175; woolen factory, 50; grist-mill, 50; saw-mill, 25. All these mills can run at full capacity all the time, and water is always wasting over the dam. The mills are run night and day, and are seldom troubled by high water, and only about 4 days per year by cold weather. It is said that, by extending the race, an additional fall of about 9 feet can be obtained, making 45 feet in all, in a distance of about a mile.

The river has been gauged here by H. Eaton Coleman, civil engineer, and county surveyor of Pittsylvania county, Virginia, who found the discharge to be 600 cubic feet per second "at mean low water". But as a single measurement of the flow has little value, I have made some estimates from the drainage area, and the results are given in the following table:

Table of power on Smith's river at Leaksville, N. C.

State of flow (see pages 18 to 21).	Drainage area.	Flow per second.	Horse-power available, gross.			Horse-power utilized, net.	Per cent. of minimum utilized.
	Sq. miles.	*Cubic feet.*	*1 foot fall.*	*36 feet fall.*	*45 feet fall.*		
Minimum	600	90	10.3	371	465	300	100
Minimum low season		132	15	540	675		
Low season, dry years		150	17	612	765		
Maximum, with storage		528	60	2,160	2,700		

The results in this table will be surprising to some who are prone to overestimate power. A discharge of 600 cubic feet per second at low water would correspond to 1 cubic foot per square mile of drainage area, or over 1 inch of rainfall per month, and for a dry month. An examination of the table on page 21 will show that this cannot be so unless there are some remarkable springs in the drainage-basin; and, in fact, it is sufficient to refer to the gauging of the Dan by the United States engineers, made at a point near South Boston, above which the drainage area is about 2,600 square miles, and which gave 990 cubic feet per second "at low water", but probably not the minimum. Even this would give per 600 square miles of drainage area, if the discharge is taken proportional to the drainage area, only 229 cubic feet per second, and the absolute minimum would be considerably less. The flow in the dry season of ordinary years would, perhaps, be 190 cubic feet per second, giving about 775 horse-power, with a fall of 36 feet. My estimate gives 100 per cent. of the minimum power used, but Major Morehead states that they "can't miss the water used by the mills". It is not impossible that the power utilized has been overestimated, which would tend to explain this result. The cotton factory runs 101 looms and about 4,800 spindles. The goods manufactured are brown sheetings, yarns, sewing-thread, and knitting-cotton. In the woolen-mill there is one set of cards, and in the grist-mill 4 run of stones. According to these data, without further particulars, 300 horse-power would seem to be too high an estimate of the power utilized. It is evident, however, that this power is a most excellent one in all respects—one of the finest in northwestern North Carolina. Reidsville is Major Morehead's shipping point.

About 2,000 feet above Major Morehead's dam is a fall of about 6 feet in 50, not used, but easily controlled.* It might be used at the factory below by raising the dam.

The power above this point is used only by saw- and grist-mills, in regard to which I have no detailed information. Enough was learned, however, to show that the river offers fine sites for power all the way up, the principal disadvantage being their inaccessibility. The river has no tributaries of much importance.

The town of Leaksville has a considerable trade in tobacco, which is the great staple of the county; but wheat and corn are also grown in considerable quantities on the fertile bottoms of the Dan, Smith, and Mayo rivers.

Above Smith's river are several unimportant tributaries to the Dan, on some of which are small mills. They are similar in character to the other tributaries below Smith's river. On Cascade creek, a small stream entering from the north below Smith's river, Dr. J. G. Brodneax has a small saw- and grist-mill, and a very good small power, with a fall of 15 or 16 feet. Timber is very cheap in this vicinity, and wooden dams can be erected at very small cost.

The next large tributary above Smith's river is Mayo river, from the north, a stream which, like Smith's river, takes its rise on the eastern slope of the Blue Ridge, in the western part of Patrick county, Virginia, and which, after flowing in a general southeasterly direction through Patrick county and a corner of Henry county, Virginia, and Rockingham county, North Carolina, joins the Dan a little below Madison, and just above Roberson's fish-trap shoal. Its length, in a straight line, is about 55 miles, and along the general course of the stream about 60 miles, but probably considerably more if all of its windings are followed. The only town on the stream is Taylorsville, the county seat of Patrick county. Its total drainage area is about 316 square miles, of which 60 square miles are above Taylorsville, and its principal tributary is the North Mayo, from the north, draining about 90 square miles. Its drainage-basin is, in all respects, similar to that of Smith's river. The fall of the stream is considerable, but it is said to be more uniform than that of either the Dan or Smith's river, and with not so many rapids and falls. The bed is rock almost everywhere, the banks high, and not many low grounds subject to overflow. In the absence of gaugings I have estimated the flow and the power of the stream at its mouth as in the following table:

Flow and power of Mayo river at its mouth.

State of flow (see pages 18 to 21).	Drainage area.	Flow per second.	Horse-power available, gross.
	Square miles.	*Cubic feet.*	*1 foot fall.*
Minimum	316	40	4.7
Minimum low season		57	6.5
Low season, dry years		65	7.4
Maximum, with storage		278	31.6

* Information from Major Morehead.

The power on the stream is used only for small grist- and saw-mills, but there are many sites not in use. The first, ascending the river, is about 1 mile from Madison, and the same distance from the mouth of the stream, used until recently for a corn- and saw-mill. The dam is a natural ledge, and the total fall of the shoal is said to be 32 feet. This site has not been used for ten years, but is said to be one of the best in the vicinity, with safe location for mills and little trouble with high water or overflow. It is owned by Mr. Robert Lewis.

About 2 miles further up the stream is a flour-mill, and above there are other small ones. There is very little bottom-land on the river for some six miles from its mouth, and the fall in that distance is very considerable, ledges of rock crossing the stream all the way. Above this, however, the stream is flat for 15 or 20 miles, and the facilities for power are not so good.

Above the Mayo there are several small creeks flowing into the Dan, some of which have power used, and all of which have considerable available. They are good streams for power, and, so far as I can learn, are not subject to such great variations in flow as those farther east. The powers they afford are small, but sufficient to run small grist- and saw-mills—sufficient for the needs of the people. Being easily dammed, and having considerable fall, they are preferred to the Dan river for small powers. The most important tributary above the Mayo is Town fork, which joins the Dan just above Shoe-Buckle island shoal; but regarding it or the other tributaries above I have no detailed information.

All of these tributary creeks, as well as the Dan river itself, are subject to sudden and quite heavy freshets, but they have so much fall that, in general, not much damage is done, although on the Dan, even above Danville, there are many bottoms which are overflowed at times. The freshets are, in general, short, lasting usually, it is said, only four or five days.

Finally, it may be said of all the valley of the Dan, and particularly of the upper part, that the climate is exceedingly salubrious (much more so than in the valley of the Roanoke, especially its lower part), the soil fertile, and the people industrious and hospitable. The advantages for manufacturing are, in every respect, excellent, except as regards accessibility, and it is to be hoped that the two railroads which are now projected up the valley may soon remove that objection.

THE STAUNTON RIVER.

This stream rises in Montgomery and Floyd counties, Virginia; flows first northeast into Roanoke; thence southeast, forming the boundary between Bedford, Campbell, and Charlotte on its left, and Franklin, Pittsylvania, and Halifax on its right, uniting with the Dan in Mecklenburg to form the Roanoke. Its length, in a straight line, is about 110 miles, and by the general course of the river perhaps 200, and still more if all its windings are followed. There are no large towns on the stream. The river is known as the Roanoke in the upper part of its course, in Montgomery and Roanoke counties.

The river and harbor bill of June 18, 1878, authorized a survey of the river between Brook Neal and Roanoke station, on the Richmond and Danville railroad, which was executed by Mr. S. T. Abert, whose reports are to be found in the reports of the Chief of Engineers, 1879, p. 622, and 1880, p. 780. By the act of March 3, 1879, the sum of $5,000 was appropriated for the work of improving the navigation of the river between these points, and by that of June 14, 1880, $7,500. The present project contemplates the securing of a navigable channel not less than 35 feet wide and 2 feet deep through the ledges and sand-bars, and a slope of water-surface at the rapids not greater than 10 feet to the mile, the cost being estimated at $57,670. These are the only works of navigation projected on the river. The stream is now navigable to Cole's ferry, a distance of 45½ miles, the depth being 1½ feet at low water.

The Staunton river drains a total area of about 3,450 square miles. Proceeding up the river, its principal tributaries from the north are, in their order, Bluestone creek, Ward's fork, Falling river, Otter river, Goose creek, and from the south, in the same order, Pig and Blackwater rivers.

The drainage-basin of the Staunton resembles that of the Dan so closely that a detailed description will not be necessary. The map annexed will show its general form and dimensions. As regards the bed and banks of the stream, the freshets, the facilities for storage, the soils, vegetation, people, and products, all the general remarks which were made in the case of the Dan will apply also to the Staunton. The river takes its source, however, considerably higher in the mountains than the Dan, its source being west of the Blue Ridge, through a gap in which it passes at the northern edge of Franklin county. One of the effects of this will be, perhaps, to render the flow of the stream more variable than that of the Dan, and from what I can learn its freshets seem to be rather more violent, the river rising between 30 and 40 feet above low water between Brook Neal and Roanoke station. But another effect of the position of the sources of the river beyond the Blue Ridge will be that the amount and distribution of the rainfall on its upper part will be different from what they are in the basin of the Dan; and although I am unable to state with accuracy to what extent or just in what way, it seems probable, from the Smithsonian charts, that the amount of rainfall will be rather less in the case of the Staunton, while its distribution through the year will be a little more uniform—less rain falling in winter on the upper Staunton than on the upper Dan. It does not seem improbable that the resultant effect of these changes will be to render the flow of the Staunton, as a whole, smaller in proportion to its drainage area than that of the Dan, while the freshets of the former may, perhaps, be more violent. As a whole, however, the mean annual rainfall on the basin of the Staunton may be taken at 42–44 inches, of which 12 fall in spring, 10 or 12 in summer, 10 in autumn, and 10 in winter.

The following table will show the declivity of the river:

Staunton river—Table of declivity.

Place.	Distance from Clarksville.	Elevation above tide.	Distance between points.	Fall between points.	Fall between points.
	Miles.	*Feet.*	*Miles.*	*Feet.*	*Feet per mile.*
Clarksville, mouth of river	0	269	22	36	1.64
Roanoke station, crossing of Richmond and Danville railroad	22	305	32	50	1.56
Brook Neal, end of United States survey	54	355	30	145	4.83
Crossing of Virginia Midland railroad	84	500	90	570	6.33
Crossing of Atlantic, Mississippi and Ohio railroad, 6 miles west of Salem	174	1,070	12	175	14.58
Crossing of Atlantic, Mississippi and Ohio railroad, 1 mile west of Big Spring	186	1,245			

The elevations given were furnished by railroad officials, with the exception of those of Clarksville and Brook Neal, which are calculated from government reports. The distances were measured on the map, following the windings of the rivers as nearly as possible, and they are believed to be very nearly accurate.

In the twenty-second report of the board of public works of Virginia is a report on a survey of the Staunton river by J. J. Couty. It is there stated that the fall from the Dan river, at the head of Nelson's island—probably at Skipwith's thoroughfare—to Brook Neal is 84.85 feet in a distance of nearly 49 miles, which agrees quite well with the figures given above.

Mr. Abert states that, according to an old survey, the fall from Smith's gap, where the river breaks through the Blue Ridge, to Clarksville—a distance of 112 miles—is 322.61 feet, or, on the average, 2.88 feet per mile.

No records of gaugings being at hand, I am again obliged to resort to estimates of flow and power based on the drainage areas.

The river is crossed by four railroads: by the Richmond and Danville road at Roanoke station, about 22 miles above Clarksville (by the river); by the Virginia Midland road at a point between Ward's bridge and Leesville, about 84 miles above Clarksville; and by the Atlantic, Mississippi and Ohio road at a point a little west of Salem, and about 174 miles above Clarksville; and further on again, at a point some 186 miles above the same place; but as the two first-named roads cross the stream nearly at right angles, all that portion of the river lying east of the Blue Ridge is very inaccessible, as will be seen from the map, except that portion for a short distance above the crossing of the Virginia Midland road, which is accessible from the branch of that road extending to Rocky Mount, Franklin county. That portion which lies west of the Blue Ridge is easy of access from stations on the Atlantic, Mississippi and Ohio railroad, which follows the valley of the stream for some distance.

I found it difficult to obtain much information regarding the water-power of the stream. The country is thinly settled, and the people have paid very little attention to the subject of water-power, there being only small grist- and saw-mills, with a foundry or two, in the whole valley of the Staunton. The power at present utilized is tabulated below from the returns of the enumerators, but regarding the available power I cannot present any definite figures. There is no doubt, however, that the Staunton and its tributaries offer many valuable sites for power, some of which could be rendered available at a very small cost. The following brief notes comprise all the information that I was able to collect with the limited time at my disposal.

Below Roanoke station, although there are some rapids, very little power ever has been used, and only for primitive grist- and saw-mills, the former running two or three sets of stones. The principal fall occurs at Tally's falls, but regarding it I have no particulars. The average width of the river in this section of its course is about 450 feet, but at Tally's falls it is wider, and the channel is broken up with rocks and islands.

Between Roanoke station and Brook Neal the river is navigated by bateaux, and by a small steamer drawing 14 inches when loaded, which is, however, unable to navigate the stream at low stages of the water. The land in this vicinity is very fertile, and is believed to be the best tobacco land in the state of Virginia. The width of the river in this section varies from 260 to 300 feet, and the banks are 12 to 22 feet high. In November, 1877, a flood occurred, which was the highest known in this vicinity, the rise being 36.33 feet above low-water at Roanoke station and 43 feet at one other point (Cole's ferry); but the banks being protected by a continuous fringe of willows, whose fibrous roots hold the soil together very effectively, are not much affected by the current, even in such heavy freshets.

The principal shoals between Roanoke station and Brook Neal are given in the following table, taken from Mr. Abert's report. Whether these shoals are practically available for power I cannot say, but it is evident that none of the shoals present remarkable powers, like some of those on the Dan.

Above Brook Neal there are several shoals with considerable fall, mention having been made of Seven Islands shoal, just above Brook Neal, Rowark's falls, and Dudley's falls. There are also several small grist-mills on the stream, all having rough wing-dams. There is said to be not a single dam entirely across the stream, except perhaps up in the mountains.

The estimates of power given in the latter part of the table are entitled to little reliance, and are only inserted to give a rough idea of the available power of the river as compared with that of the Dan. If these estimates are much out of the way, they are wrong for both rivers probably, because similar suppositions have been made in both cases.

Staunton river—Summary of power.

Locality.	Distance from Clarksville.	Drainage area.	Rainfall.					Total fall.		Horse-power available, gross.*			
			Spring.	Summer.	Autumn.	Winter.	Year.	Height.	Length.	Minimum.	Minimum low season.	Maximum, with storage.	Low season, dry years.
	Miles.	*Sq. ms.*	*In.*	*In.*	*In.*	*In.*	*In.*	*Feet.*	*Feet.*				
Clark's shoal	25.93	....	12	10-12	10	10	42-44	0.891	1,640	....	....	....	....
Watkins' reef	27.39	....	12	10-12	10	10	42-44	0.694	650	....	....	....	....
Horseback shoal	28.26	....	12	10-12	10	10	42-44	6.426	18,890	....	....	....	....
Hawk Mountain shoal	32.77	....	12	10-12	10	10	42-44	3.774	3,450	....	....	....	....
Cove shoal No. 3	34.00	....	12	10-12	10	10	42-44	0.707	2,190	....	....	....	....
Cove shoal No. 2	34.70	....	12	10-12	10	10	42-44	0.247	1,920	....	....	....	....
Cove shoal No. 1	35.67	....	12	10-12	10	10	42-44	0.981	2,420	....	....	....	....
Britton's shoal	38.84	....	12	10-12	10	10	42-44	1.411	1,780	....	....	....	....
Dennis' dam	41.25	....	12	10-12	10	10	42-44	0.979	890	....	....	....	....
Rice's shoal	41.93	....	12	10-12	10	10	42-44	1.391	1,370	....	....	....	....
Michael's dam	43.43	....	12	10-12	10	10	42-44	0.500	185	....	....	....	....
Bruce's shoal	43.86	....	12	10-12	10	10	42-44	2.945	10,970	....	....	....	....
Kirkpatrick's shoal	45.86	....	12	10-12	10	10	42-44	2.733	7,510	....	....	....	....
Henry's shoal	49.79	....	12	10-12	10	10	42-44	2.403	4,425	....	....	....	....
Miller's shoal	51.23	....	12	10-12	10	10	42-44	0.996	785	....	....	....	....
White Rock falls	51.91	....	12	10-12	10	10	42-44	3.000	1,075	....	....	....	....
Between mouth and mouth of Falling river	0 54	3,450 2,722	12	10-12	10	10	42-44	86.00	*Miles.* 54	5,400	6,600	24,000	7,500
Between mouth of Falling river and mouth of Otter river	54 80	2,500 2,257	12	10-12	10	10	42-44	125.0±	26	6,100	7,500	28,500	8,600
Between mouth of Otter river and mouth of Goose river	80 91	1,802 1,836	12	10-12	10	10	42-44	60.0±	11	2,275	2,775	10,500	3,175
Between mouth of Goose river and mouth of Pig river	91 102	1,556 1,500	12	10-12	10	10	42-44	70.0±	11	2,000	2,600	10,500	2,975
Between mouth of Pig river and mouth of Blackwater river	102 113	1,088 1,043	12	10-12	10	10	42-44	70.0±	11	1,250	1,675	7,350	1,900
Between mouth of Blackwater river and railroad crossing near Salem	113 174	730 250±	12	10-12	10	10	42-44	380.0±	61	3,000	4,200	19,000	4,800
Total between mouth and Salem	0 174	3,450 250±	12	10-12	10	10	42-44	800.0±	174	20,025	25,350	99,850	28,950

* See pages 18 to 21.

TRIBUTARIES OF THE STAUNTON RIVER.

The first tributary met with in ascending the river is Bluestone creek, entering from the north in Mecklenburg county, about 3 miles above Clarksville, its sources being in Charlotte county, and its general course nearly south. Its length is about 17 miles, and its drainage area about 85 square miles. Details regarding its water-power could not be obtained.

The next stream worth mentioning is Ward's fork, also from the north, and draining an area of 191 square miles, entirely in Charlotte county. Its course is nearly south, and its length, in a straight line, about 20 miles. This stream is sometimes known as the Little Roanoke. Regarding its available power I have no data. That which is used is tabulated beyond. The elevation of the stream at the crossing of the Richmond and Danville railroad, some 4 miles from its mouth, is 322 feet.

Falling river, the next tributary worth naming, enters the river about 2 miles below Brook Neal, from the north. Its length is about 25 miles along its general course, and it drains an area of about 213 square miles in Campbell and Appomattox counties. It has considerable fall, and is said to be a good stream for power, running several saw- and grist-mills and a foundry, all herein tabulated. Details of its available power could not be obtained with the time at disposal. In fact, examinations of all these streams would be necessary if any accurate conception of their value for power is to be formed. The information given by most persons with whom I orresponded in this section of the country was very general, being mostly confined to statements that the streams had "a rapid fall", "plenty of sites for manufacturing establishments", and the like.

Otter river is the next considerable tributary, being larger than any thus far mentioned. It rises near the Peaks of Otter, in the Blue Ridge, in the northwestern part of Bedford county, whence it pursues a general course nearly southeast through Bedford and Campbell counties, entering the Staunton in the latter county, about 4 miles below the crossing of the Virginia Midland railroad. Although there are very few mills on the stream, as will be seen by turning to the table, it is said to be an excellent stream for power, and it must certainly have a very large fall, descending, as it does, from the Blue Ridge. Its length is about 35 miles, following its general course, and it drains an area of 365 square miles. Its water-power must be very considerable, and I think there is no doubt that fine sites may be found along it at many points, although I heard of no particular ones.

The next tributary, the Goose river, enters the Staunton from the north at Leesville, about 7 miles, by the stream, above the crossing of the Virginia Midland railroad. It rises, like the Otter river, on the eastern slope of the Blue Ridge, and flows during its whole course nearly parallel to the latter stream, which it much resembles in general character. Its length is about the same, but its drainage area smaller, viz, 280 square miles. Like the Otter, its water-power is utilized only for a few small grist, and saw-mills, although its available power must be considerable.

Pig river, from the south, is the next important tributary, being in fact the largest tributary of the Staunton. It rises in the Blue Ridge near the southwestern corner of Franklin, pursues a course nearly east through that county and into Pittsylvania, where it makes a bend to the north and enters the Staunton about 11 miles, by the river, above Leesville, its total length, following its general course, being about 45 or 50 miles, and its drainage area about 413 square miles. It receives as tributaries several large creeks, all of which are said to afford good power. The Pig river is a rapid stream, and probably affords many sites for power—in fact, there seems no doubt that it does—but it is scarcely used at all, as the table of statistics shows.

The last tributary of the Staunton worth mentioning specially is Blackwater river, which rises in the western part of Franklin county, pursues a course nearly parallel to that of Pig river, and joins the Staunton about a mile above the northeast corner of Franklin county. Its total length, following its general course, is about 35 miles, and its drainage area 313 square miles. It is fair to conclude that its general character is nearly the same as that of Pig river, and that it affords a very large amount of unutilized power.

The information which I am able to present regarding these tributaries of the Staunton, notwithstanding the large amounts of power they possess, is very meager, and this is due to several causes, among which may be mentioned their inaccessibility in general, and the fact that so little power is used on them that it is difficult to find persons well acquainted with their water-power. It is also due in great measure to the fact that, unlike the streams farther south, their declivities are, on the whole, quite uniform, with few precipitous falls. As regards their general character, their banks are said to be good as a rule, and their beds are gravel and sand, with rock never at a great depth, and sometimes at the surface. Most of the low grounds along their banks are subject to overflow in times of freshet, the latter being severe, but short. This region is, in fact, a sort of a transition district from the glacial region of the north, where the streams flow in beds of gravel and sand, cut down into the deposits of glacial drift, and with uniform declivities, and the non-glacial southern region, where drift-deposits do not occur, except in the eastern division, and where the streams pour often over ledges of rock which cross their course, falling often 20 to 50 feet in a few hundred, and without having evened out their beds to a uniform declivity and obliterated these falls by filling them up with deposits brought down from above.

While the streams of the middle states have comparatively few precipitous falls, those of the southern Atlantic states have many. But although there are no drift-deposits in the middle and western divisions of these states, there are quite extensive deposits of gravel and sand which owe their origin to other causes; and there will be occasion to show that many of the southern streams are gradually filling up and evening out their beds to a uniform declivity, as the streams of the middle states have already done.

The following table contains some estimates of the flow of the Staunton and its tributaries, not entitled to much confidence, but serving to give a rough idea of the power they would afford (see pages 18 to 21):

Staunton river and tributaries—Table of estimated flow and power.

River and place.	Drainage-basin.	Rainfall.					Flow, per second.				Horse-power available, 1 foot fall, gross.			
		Spring.	Summer.	Autumn.	Winter.	Year.	Minimum.	Minimum low season.	Maximum, with storage.	Low season, dry years.	Minimum.	Minimum low season.	Maximum, with storage.	Low season, dry years.
	Sq. miles.	*In.*	*In.*	*In.*	*In.*	*In.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*				
Staunton, at mouth	3,450	12	10-12	10	10	42-44	655	759	2,760	867	74.5	86.2	313.6	98.5
Staunton, above Bluestone	3,365	12	10-12	10	10	42-44	605	740	2,690	845	68.8	84.1	306.0	96.0
Staunton, above Ward's fork	3,033	12	10-12	10	10	42-44	546	667	2,425	762	62.0	75.8	275.0	86.6
Staunton, above Falling river	2,509	12	10-12	10	10	42-44	450	550	2,000	630	51.1	62.5	227.0	71.6
Staunton, above Otter river	1,892	12	10-12	10	10	42-44	321	397	1,600	450	36.5	45.1	182.0	51.1
Staunton, above Goose river	1,556	12	10-12	10	10	42-44	256	326	1,322	373	29.2	37.1	150.0	42.4
Staunton, above Pig river	1,088	12	10-12	10	10	42-44	163	218	957	250	18.5	24.8	109.0	28.4
Staunton, above Blackwater river	730	12	10-12	10	10	42-44	109	146	642	167	12.4	16.6	73.0	19.0
Bluestone creek	191	12	10-12	10	10	42-44	.....	.....	.....	.....	.....	.....	.....	.....

Table of estimated flow and power—Continued.

River and place.	Drainage basin.	Rainfall.					Flow, per second.				Horse-power available, 1 foot fall, gross.			
		Spring.	Summer.	Autumn.	Winter.	Year.	Minimum.	Minimum low season.	Maximum, with storage.	Low season, dry years.	Minimum.	Minimum low season.	Maximum, with storage.	Low season, dry years.
	Sq. miles.	*In.*	*In.*	*In.*	*In.*	*In.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*				
Ward's fork (Little Roanoke)	85	12	10–12	10	10	42–44	....	....	....	....	....	....	....	....
Falling river	213	12	10–12	10	10	42–44	....	....	....	....	....	....	....	....
Otter river	365	12	10–12	10	10	42–44	51	73	321	83	5.8	8.3	36.5	9.4
Goose river	280	12	10–12	10	10	42–44	39	56	246	64	4.5	6.3	28.0	7.2
Pig river	413	12	10–12	10	10	42–44	58	82	363	94	6.6	9.3	41.3	10.7
Blackwater river	313	12	10–12	10	10	42–44	44	62	275	71	5.0	7.1	31.3	8.1

Roanoke river and tributaries—Table of power utilized.

Name of stream.	Tributary to what.	State.	County.	Kind of mill.	No. of mills.	Total fall used.	Total horse-power used.
						Feet.	
Roanoke river	Albemarle sound	North Carolina	Bertie	Saw	1	......	30
	Do	do	Northampton	Flour and grist	2	16	76
	Do	do	Halifax	do	3	54	110
	Do	do	do	Saw	1	18	10
	Do	do	do	Cotton-gin	2	36	15
	Do	do	do	Foundry	1	18	15
	Do	Virginia	Mecklenburg	Flour and grist	2	11½	41
	Do	do	do	Saw	2	11½	41
Tributaries of	Roanoke river	North Carolina	Washington	Flour and grist	2	18	22
	Do	do	Bertie	do	4	34½	67
	Do	do	do	Saw	2	16	35
	Do	do	Martin	do	2	19	42
	Do	do	do	Flour and grist	3	29	40
	Do	do	Northampton	do	3	29	32
	Do	do	Warren	do	7	111	178
	Do	do	do	Saw	4	54	82
	Do	do	Granville	Flour and grist	13	178½	163
	Do	do	do	Tobacco	1	10	8
	Do	do	do	Saw	4	59½	62
	Do	Virginia	Mecklenburg	do	8	110	171
	Do	do	do	Flour and grist	17	200	331
	Do	do	do	Cotton-gin	1	31	16
Dan river	Do	do	Halifax	Flour and grist	3	21	60
	Do	do	Pittsylvania	do	2	25	65
	Do	do	do	Saw and planing	1	7	50
	Do	do	do	Foundry and machine-shop.	2	17	70
	Do	North Carolina	Stokes	Flour and grist	2	25	38
Hyco river	Dan river	do	Person	do	2	26	34
	Do	do	do	Saw	2	26	26
	Do	do	Caswell	Flour and grist	3	41	44
	Do	Virginia	Halifax	do	2	18	35
	Do	do	do	Saw	1	8	20
Bannister river	Do	do	Pittsylvania	Flour and grist	2	24	40
	Do	do	Halifax	do	3	35	148
	Do	do	do	Saw	1	10	20
	Do	do	do	Tobacco	1	10	18
Smith's river	Do	North Carolina	Rockingham	Cotton factory	1	30	175†
	Do	do	do	Woolen factory	1	36	50†
	Do	do	do	Flour and grist	1	28	50
	Do	do	do	Saw	1	12	20
	Do	do	do	Millwrighting	1	28	35
	Do	Virginia	Henry	Flour and grist	2	20	60
	Do	do	do	Saw	3	46	83
	Do	do	Patrick	Flour and grist	1	13	20
Mayo river	Do	North Carolina	Rockingham	do	1	20	20
	Do	Virginia	Patrick	do	1	15	16
Other tributaries of	Do	North Carolina	Granville	do	3	46	40
	Do	do	do	Saw	2	53	30

Table of power utilized—Continued.

Name of stream.	Tributary to what.	State.	County.	Kind of mill.	No. of mills.	Total fall used.	Total horse-power used.
						Feet.	
Other tributaries of	Dan river	North Carolina	Person	Saw	4	.....	65
	Do	do	do	Flour and grist	6	89	92
	Do	do	Caswell	do	14	176	216
	Do	do	do	Saw	8	82	126
	Do	do	do	Agricultural implements.	2	32	30
	Do	do	Rockingham	Flour and grist	12	160½	203
	Do	do	do	Saw	9	120¼	145
	Do	do	do	Blacksmithing	1	10	6
	Do	do	Stokes	Flour and grist	18	264	285
	Do	do	do	Saw	7	96½	130
	Do	Virginia	Halifax	Flour and grist	19	344	354
	Do	do	do	Saw	11	243	194
	Do	do	do	Foundry	1	8	8
	Do	do	do	Agricultural implements.	3	37	24
	Do	do	Pittsylvania	Flour and grist	18	307	412
	Do	do	do	Saw	4	77	70
	Do	do	Henry	Flour and grist	19	331	241
	Do	do	do	Saw	6	142	121
	Do	do	do	Agricultural implements.	1	17	30
	Do	do	do	Leather	1	16	6
	Do	do	Patrick	Flour and grist	1	15	15
Staunton	Roanoke	do	Halifax	do	1	6	12
	Do	do	do	Saw	1	14	15
	Do	do	Charlotte	Flour and grist	1	10	25
	Do	do	Campbell	do	3	14½	135
	Do	do	Bedford	do	2	18	20
	Do	do	do	Saw	1	3	7
	Do	do	Pittsylvania	do	1	14	12
	Do	do	Roanoke	do	1	10	16
	Do	do	do	Flour and grist	3	30	60
	Do	do	Montgomery	do	2	25	45
	Do	do	do	Saw	1	.....	20
	Do	do	do	Furniture	1	10	6
Little Roanoke	Staunton	do	Charlotte	Flour and grist	2	10	32
	Do	do	do	Saw	1	7	18
Falling creek	Do	do	Campbell	Foundry	1	10	20
	Do	do	do	Flour and grist	3	35	70
	Do	do	Appomattox	do	1	12	25
	Do	do	do	Saw	1	12	25
Otter river	Do	do	Bedford	Flour and grist	3	44	43
	Do	do	do	Saw	3	45	35
	Do	do	do	Woolen	1	.....	.....
	Do	do	Campbell	Flour and grist	1	2	25
Goose river	Do	do	Bedford	do	6	77	93
	Do	do	do	Saw	4	58	32
Pig river	Do	do	Franklin	Flour and grist	4	.....	62
	Do	do	do	Saw	1	16	25
Blackwater river	Do	do	do	Flour and grist	2	28	22
	Do	do	do	Saw	1	9	20
Other tributaries of	Do	do	Halifax	Flour and grist	6	86	111
	Do	do	Charlotte	do	10	199	223
	Do	do	do	Saw	2	41	36
	Do	do	Campbell	Flour and grist	8	105½	238
	Do	do	do	Saw	2	26½	60
	Do	do	Bedford	Flour and grist	15	229	253
	Do	do	do	Saw	10	151	136
	Do	do	Pittsylvania	Flour and grist	1	18	12
	Do	do	do	Saw	2	26	36
	Do	do	Franklin	do	5	80	50
	Do	do	do	Flour and grist	21	310	307
	Do	do	do	Wheelwrighting	1	15	4
	Do	do	Roanoke	Flour and grist	12	176	252
	Do	do	do	Saw	8	100	105
	Do	do	do	Foundry	1	7	4
	Do	do	do	Fertilizers	1	22	15
	Do	do	Montgomery	Flour and grist	2	21	28

III.—THE TAR RIVER AND TRIBUTARIES.

THE TAR RIVER.

This river takes its rise in Person and Granville counties, North Carolina, flows in a southeasterly direction through Franklin, Nash, Edgecombe, and Pitt counties, and empties into the Pamlico river, in Beaufort, near the town of Washington, its length, in a straight line, being about 120 miles, and by the river perhaps 175. The principal towns on the stream are Washington, Greenville, Tarboro', Rocky Mount, and Louisburg. Tarboro', 53 miles from Pamlico river, is the head of navigation, and it is hoped to secure ultimately a channel 3 feet in depth at all stages of the water up to this point, but at present this depth exists only during nine months of the year. The obstructions to navigation consist of stumps, snags, fallen trees, and artificial obstructions placed there during the war.

The river drains an area of about 3,000 square miles, the greater part of which lies north of the stream, from which side the principal tributaries—Swift and Fishing creeks—enter, draining, respectively, 340 and 760 square miles. The stream crosses the fall-line at Rocky Mount, below which point there is no water-power. The general character of the drainage-basin resembles that of the Roanoke. The leading productions are tobacco, corn, and cotton, most of the cotton being raised in the eastern part, and most of the tobacco in the western. There are no lakes in the basin. The bed of the stream above the fall-line is rock in places, but generally sand, clay, gravel, or mud, the declivity of the stream being quite uniform. Above Rocky Mount the bottoms are narrower than on the Roanoke, and the banks are generally high enough to confine the river, except in very heavy freshets. Below Rocky Mount the banks are often overflowed, the river rising sometimes 25 feet at Tarboro'.

The average annual rainfall on the basin of the Tar is about 50 inches, but above the fall-line it is less—about 46 or 48 inches, distributed nearly as follows: Spring, 12; summer, 14; autumn, 10; winter, 11.

The fall of the stream below Rocky Mount is said not to exceed 1 or 1½ feet per mile, making the total fall below that point between 50 and 75 feet. The elevation of the stream at the crossing of the Raleigh and Gaston railroad is 188 feet,* making the fall between that point and the head of the fall at Rocky Mount about 2 feet to the mile or less, the distance being in the neighborhood of 60 miles. No gaugings of the stream are on record.

Ascending the stream the water-powers met with are as follows:

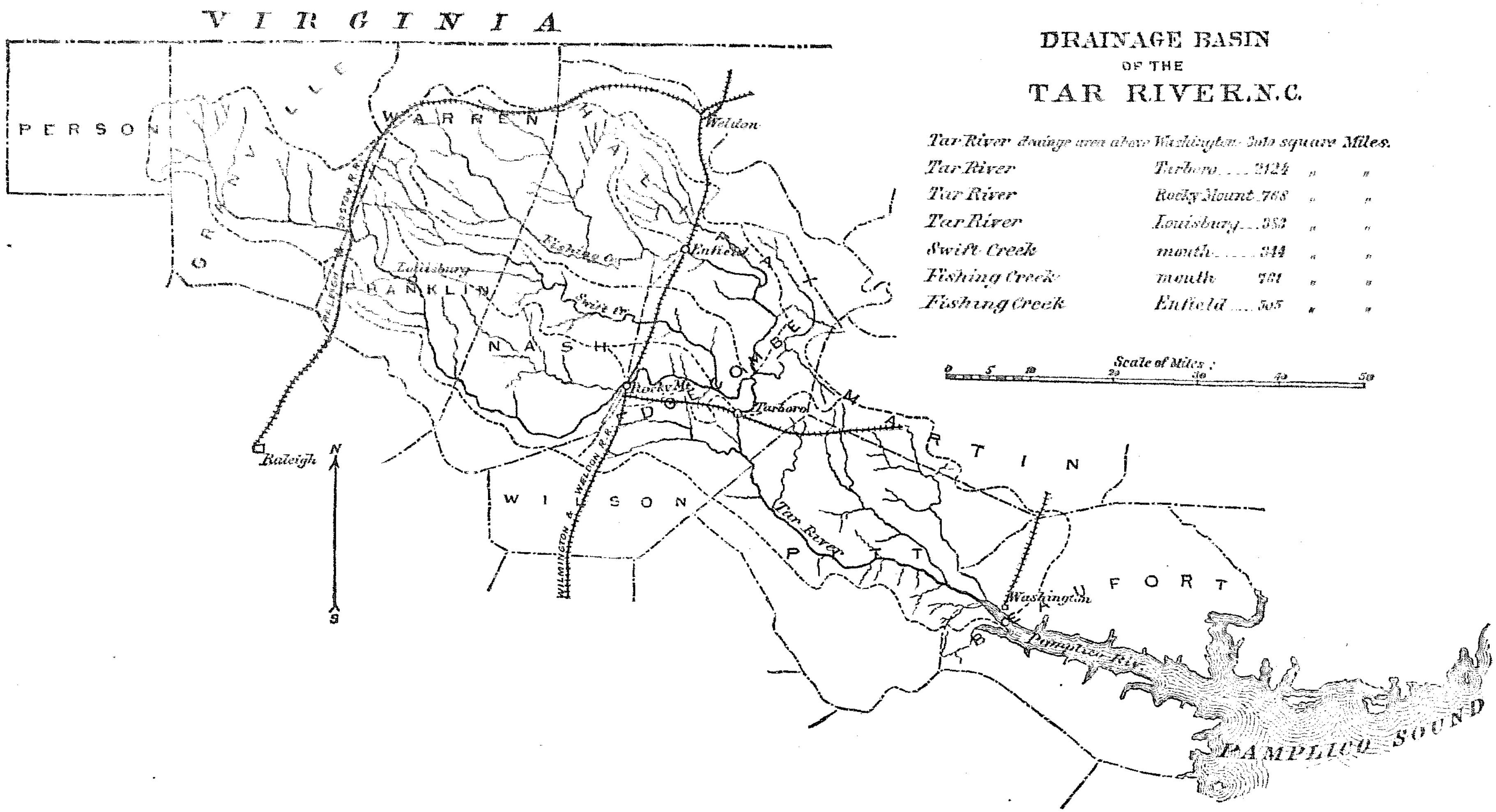
Battle's cotton factory, at Rocky Mount, known as the Rocky Mount mill, is situated on the fall-line. The dam extends entirely across the river in a broken line, part being artificial, and part natural rock. The artificial part is of granite, 600 feet long, and averaging 9.2 feet in height, and was built in 1854 at a cost of $10,000. It backs the water up only a very few hundred feet, forming no pond of any consequence. The bed of the stream is solid rock and the banks moderately high, affording safe building-sites. There is considerable fall in the stream for several hundred yards above the dam, which could probably be raised some four feet or so without doing any damage, and backing the water up to the head of a slight rift called Goodson's falls (half a mile above the dam), above which the river is sluggish for a long distance. A race 191 feet long leads from the dam to the cotton factory, where a head and fall of 16 feet 10 inches is used, with a turbine-wheel giving 155 horse-power. No steam-power is used, the water-power being ample, and there being an excess of water at all times, except in very low stages of the river. In addition to the cotton factory there is a grist- and flour-mill located at the dam, run by two overshot wheels, with 14½ feet fall and about 40 horse-power; also a saw-mill run by a turbine-wheel, with 12 feet fall and about 30 horse-power, and a second turbine-wheel, running a cotton-gin, with about 10 horse-power. The total power used at this place is therefore about 235 horse-power. It is said that the first cotton-mill in the state of North Carolina was built at this place in 1817.

The drainage area above this place is about 768 square miles, and the mean annual rainfall about 47 inches, already stated. No gaugings of the river having been made, I have been obliged to estimate the flow and the power with the results given in the following table. The total available fall may be taken as 20 feet:

Power on the Tar river at Rocky Mount.

Character of flow, (see pages 18 to 21.)	Drainage area.	Fall.	Flow per second.	Available horse-power, gross.			Utilized.		Per cent. of minimum utilized.
							Horse-power, net.	Fall.	
	Sq. miles.	*Feet.*	*Cubic feet.*	*1 foot fall.*	*16⅚ foot fall.*	*20 foot fall.*		*Feet.*	
Minimum	768	20	125	14.0	235	280	235	12–16⅚	188
Minimum low season			150	17.0	286	340			
Maximum, with storage			675	76.8	1,293	1,536			
Low season, dry years			170	19.2	323	384			

* For the elevations on the Raleigh and Gaston railroad and the Raleigh and Augusta Air-Line railroad I am indebted to the general manager, Mr. John C. Winder.


DRAINAGE BASIN
OF THE
TAR RIVER.N.C.
Tar River ... square Miles.
Tar River Tarboro ... 2124
Tar River Rocky Mount 768
Tar River Louisburg ... 352
Swift Creek mouth ... 344
Fishing Creek mouth 761
Fishing Creek Enfield ... 505
Scale of Miles:
0 5 10 20 30 40 50
VIRGINIA
PERSON
WARREN
FRANKLIN
NASH
WILSON
MARTIN
PITT
Raleigh
Weldon
Enfield
Louisburg
Rocky Mt.
Tarboro
Washington
Fishing Cr.
Swift Cr.
Tar River
Pamplico Riv.
PAMPLICO SOUND
WILMINGTON & WELDON R.R.
N
S

In very low stages of the river the water is drawn down in the pond below the crest of the dam sometimes to the extent of 6 inches; but as the pond is very small, this does not indicate that the power used is much in excess of that due to the natural flow, but only that the latter is completely utilized. Neither is Mr. Battle troubled, to any great extent, by freshets, being only obliged to stop at most a few days in the year. The dam was partially carried away in 1875, but no great damage was done. There is never any trouble with ice.

The estimates given in the above table for the power available, with storage, although it might be approximated to in the case of the Tar, whose drainage-basin is, in the upper parts, favorable in places for the construction of reservoirs, according to Professor Kerr, yet the use of this method of increasing the power would probably, as in the case of the Roanoke, be found expensive and impracticable, on account of the necessity of overflowing lands which are the most fertile and the best adapted to cultivation in the whole basin, and on account of the distance of the reservoir-sites from the fall-line. As the factory is almost on the line of the Wilmington and Weldon railroad, the facilities for transport are excellent. Although the health of this part of the state is not so good as that of the western part, no great difficulty is experienced on this account.

Above Battle's the river is sluggish for some distance, after which the fall becomes considerably greater. On the upper part of the river there are only saw- and grist-mills, and there are no sites of importance not used, although on the upper part of the stream, and on its tributaries, there are many places where power could be obtained by damming.

Between Mr. Battle's and Louisburg there are two small grist-mills and gins; the lower one a small mill with 8 feet fall, the dam being 215 feet long and 6 feet high, built of wood, at a cost of $600, and throwing the water back 1½ miles; and the upper one, that of Mr. N. R. Strickland, a saw- and grist-mill, with a dam of wood and stone 180 feet long, 7 feet high, and costing $1,000, and backing the water 7 miles, with an average width of 150 feet. At this mill a fall of 7 feet is used, and about 50 horse-power, net, with a waste of water all the time, except in times of extreme drought.

At Louisburg Col. J. F. Jones has a saw- and grist-mill using 8 feet fall and running full capacity all the time, with water wasting. The dam is of rock, 250 feet long and 8 feet high, throwing the water back 2 miles, with an average width of 150 feet; a power of about 65 or 75 horse-power is said to be used.

Above this there are no mills of importance. It will be seen that the water-power of the Tar river does not amount to much, being almost all obtained by damming, and there being no fall of any consequence except that at Battle's.

Tar river—Summary of power.

Locality.	Distance from Tarboro'.	Drainage area.	Rainfall.					Total fall.		Horse-power available, gross. †				Utilized.		Per cent. of minimum utilized.	Remarks.
			Spring.	Summer.	Autumn.	Winter.	Year.	Height.	Length.	Minimum.	Minimum low season.	Maximum, with storage.	Low season, dry years.	Horse-power, net.	Fall.		
	Miles.	*Sq. ms.*	*In.*	*In.*	*In.*	*In.*	*In.*	*Feet.*	*Feet.*						*Feet.*		
Battle's mills	20±	768						20	2,800	280	340	1,536	384	235	16.83	133	Only natural fall on river. Mill at dam.
Vivaratti's mill	34±	615	12	14	10	11	47	8	....	80	100	480	115	....	8.00	....	
Strickland's mill	46±	565						7	....	66	85	390	97	50	7.00	150	
Louisburg	75±	383						8	....	45	60	300	69	60	8.00	....	
*Between head of Battle's shoal, and Raleigh and Gaston railroad	28± / 90±	768 / 270	12	14	10	11	47	110±	*Miles.* 60±	970	1,200	5,700	1,375	....	23.00	....	

* These figures are too inexact to be of any practical value, and moreover these amounts of power are not practically available.

† See pages 18 to 21.

TRIBUTARIES OF THE TAR RIVER.

Fishing creek is the first important tributary met with in ascending the stream. It rises in Warren county, forms for some distance the boundary-line between Halifax, on the north, and Nash and Edgecombe on the south, and empties into the Tar in the latter county. Its length, measured in a straight line, is about 50 miles, and its drainage area 760 square miles. Its only tributary worth mentioning is Little Fishing creek, which enters from the north. The stream crosses the fall-line near Enfield, and the general character of its drainage-basin is the same as that of the Tar river. The water-power of the stream is not extensive, and is used for saw- and grist-mills, cotton-gins, and one cotton factory.

The first power is that of Dr. J. T. Bellamy, at the fall-line, 4 miles from Enfield, where there are a saw- and grist-mill, gin, and cotton-yarn mill. The dam is of stone, built in 1857, at a cost of $9,000, and is 160 feet long and 12 feet high, backing the water about 3 miles, and overflowing some 200 acres of swamp-land to an average depth of perhaps 7 or 8 feet. At one end of the dam is the cotton factory, and at the other the saw- and grist-mills, all using a fall of 12 feet and a total of about 50 horse-power, of which the factory uses perhaps 30, with a turbine-wheel, and with always a waste of water. The drainage area above this place being about 500 square miles, and the rainfall 47 inches, I would judge the available power to be at least 100 horse-power in the low season of dry years, 125 in the low season of ordinary years, and twice that amount, or more, during nine months—these powers being gross, but doubtless capable of being increased to a very large extent by drawing down the water in the pond during working hours. This site is 4 miles from the railroad.

The next power is that of William Burnett, 6 miles west of the railroad, at Millbrook. The dam is wood (crib-work), filled with stone, 260 feet long and 8 feet high, backing the water about three-fourths of a mile, but not throwing it out of its banks. A race 60 feet long leads to the mill—a grist- and saw-mill—where a fall of 5 feet (?) is used. The amount of water in the stream here is probably about the same as at Bellamy's. If the available fall is 8 feet, the available power is therefore about two-thirds of that at the latter place. The bed of the river here is rock, and very favorable for a dam.

The remaining powers on this creek and its tributaries are not worthy of special mention. They are included in the table below. The grist-mills generally have one, two, or three run of stones.

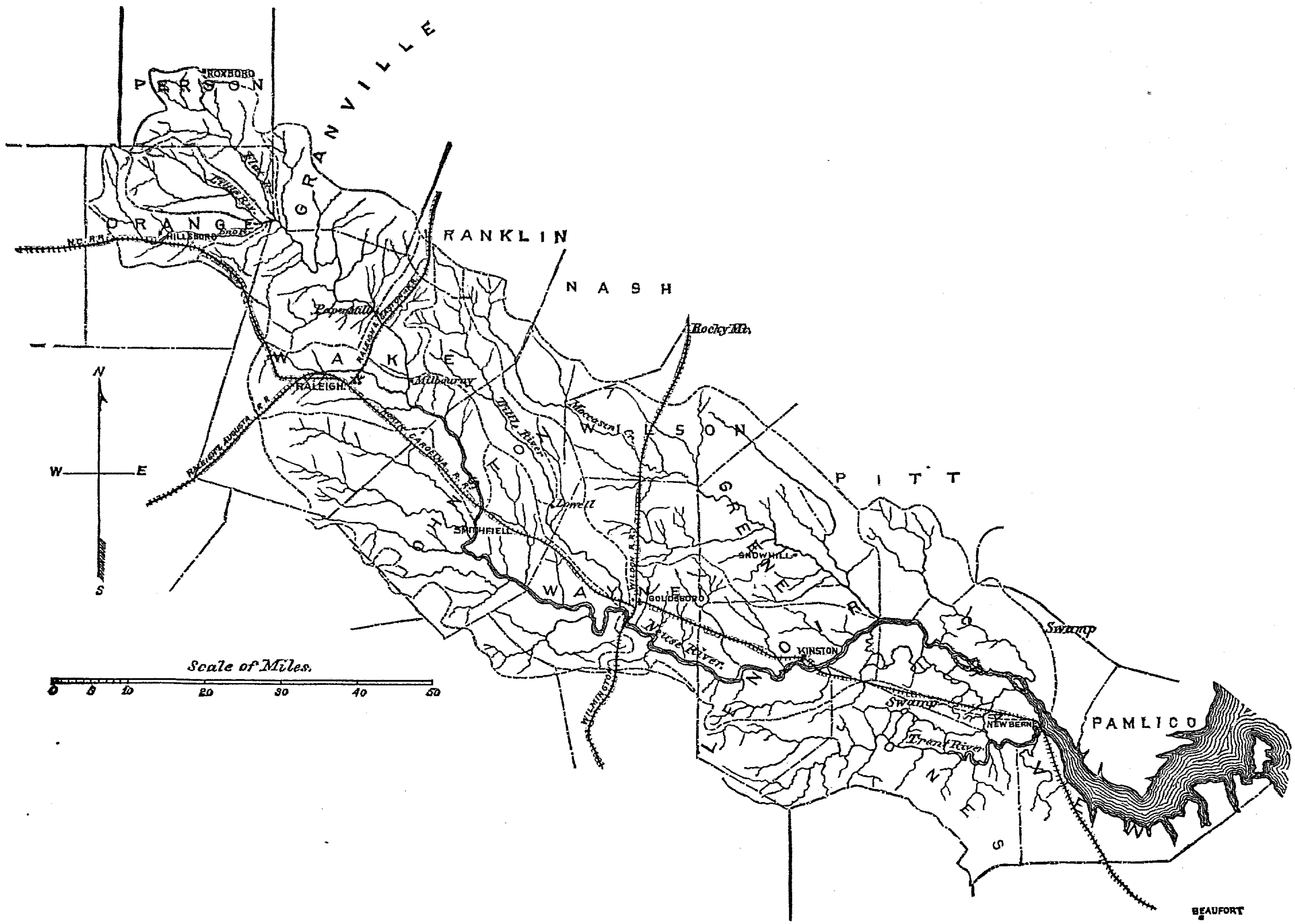
On the whole, as far as could be ascertained, the stream is not of much value for water-power, on account of its small fall and its variable flow. I heard of no good sites not used, but there are probably places where a certain amount of power could be obtained by damming.

Swift creek rises in Warren and Granville counties, where it is called Sandy creek; flows through Franklin, Nash, and Edgecombe, joining the Tar about 7 miles above the mouth of Fishing creek, its length, in a straight line, being about 50 miles, and draining an area of about 350 square miles. In general character it is similar to Fishing creek, but is said to be more sluggish, and to have lower banks. Its water-power is not valuable, and I heard of no sites not occupied. The power utilized will be found in the table. The mills are saw- and grist-mills, cotton-gins, and one cotton-yarn factory, at Laurel, belonging to Col. J. F. Jones. The latter is the most important of the utilized powers. The dam is of wood and stone, 100 feet long, 5 feet high, backing the water one mile, and giving a fall of 12 feet, with a race 60 feet long. The power is used for a grist- and saw-mill, and for a cotton-yarn factory, with 612 spindles, using perhaps, in all, 30 or 40 horse-power.

The remaining tributaries to the Tar river are of no importance, and the only mills on them are small saw-mills and grist-mills with one or two run of stones. The smaller streams nearly dry up in summer, and many of the mills have to stop grinding. The table for the utilized power of the Tar and its tributaries is compiled from the returns of the enumerators:

Table of power utilized on Tar river and its tributaries.

Stream.	Tributary to what.	State.	County.	Kind of mill.	No. of mills.	Total fall used.	Total horse-power used.
						Feet.	
Tar river	Pamplico river	North Carolina	Nash	Cotton factory	1	17	155
Do	do	do	do	Flour and grist	3	29½	85
Do	do	do	do	Saw	1	12	30
Do	do	do	do	Cotton-gin	3	27	22
Do	do	do	Franklin	Flour and grist	1	9	40
Do	do	do	do	Saw	1	9	25
Do	do	do	Granville	Flour and grist	6	90	153
Do	do	do	do	Saw	5	65	98
Fishing creek	Tar river	do	Halifax	Cotton factory	1	12	30
Do	do	do	do	Flour and grist	2	19	40
Do	do	do	do	Saw	2	19	40
Do	do	do	Warren	Flour and grist	7	100	148
Swift creek	do	do	Edgecombe	do	1	7	30
Do	do	do	Nash	do	2	19	35
Do	do	do	Franklin	do	3	30	53
Do	do	do	do	Saw	1	12	15
Do	do	do	do	Cotton factory	1	12	20
Do	do	do	Warren	Flour and grist	6	90	211
Other tributaries of	do	do	Pitt	do	4	29	74
Do	do	do	do	Saw	2	14	84
Do	do	do	Edgecombe	Flour and grist	3	35	75
Do	do	do	do	Saw	2	.....	49
Do	do	do	Halifax	Flour and grist	4	62	67
Do	do	do	Nash	do	4	27	96
Do	do	do	do	Saw	1	8	13
Do	do	do	do	Agricultural implements.	1	8	12



PERSON
ROXBORO
GRANVILLE
ORANGE
HILLSBORO
N.C. R.R.
FRANKLIN
NASH
Rocky Mt.
WAKE
RALEIGH
Raleigh & Augusta R.R.
Raleigh & Gaston R.R.
North Carolina R.R.
Millbourny
Little River
Moccasin Cr.
WILSON
PITT
JOHNSTON
SMITHFIELD
Lowell
WAYNE
GOLDSBORO
Wildon R.R.
Wilmington
GREENE
SNOWHILL
Neuse River
LENOIR
KINSTON
Swamp
Trent River
NEWBERN
JONES
CRAVEN
PAMLICO
BEAUFORT
N
S
E
W
Scale of Miles.
0
5
10
20
30
40
50

Table of power utilized on Tar river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill.	No. of mills.	Total fall used.	Total horse-power used.
						Feet.	
Other tributaries of	Tar	North Carolina	Nash	Cotton-gin	1	7	4
Do	..do	......do	Franklin	Flour and grist	14	234	251
Do	..do	......do	...do	Saw	9	135	163
Do	..do	......do	...do	Cotton-gin	2	22	18
Do	..do	......do	...do	Leather	1	15	10
Do	..do	......do	Warren	Flour and grist	5	106	112
Do	..do	......do	...do	Saw	1	15	20
Do	..do	......do	Granville	Flour and grist	11	133	186
Do	..do	......do	...do	Saw	6	91	108

IV.—THE NEUSE RIVER AND TRIBUTARIES.

Drainage-basin of the Neuse river, North Carolina.

DRAINAGE AREAS.

	Square miles.
Neuse river, at mouth	5,299
Neuse river, at New Berne	4,250
Neuse river, at Goldsboro'	2,451
Neuse river, at Smithfield	1,317
Neuse river, at Milburny	995
Neuse river, at paper-mill	890
Contentnea creek, at mouth	991
Little river, at mouth	326
Little river, at Lowell	195
Flat river, at mouth	166
Little river, at mouth	130
Eno river, at mouth	134

THE NEUSE RIVER.

The Neuse river is formed in the northwest corner of Wake county, North Carolina, by the union of three small streams, the Eno, Flat, and Little rivers, which themselves take their rise in Person and Orange counties. The Neuse flows in a general southeasterly direction through Wake, Johnston, Wayne, Lenoir, and Craven counties, emptying into Pamlico sound below New Berne, its general course, in its lower and navigable portion, being more nearly east. It forms for a short distance the boundary between Granville and Wake counties, and, near its mouth, between Lenoir, Pitt, and Pamlico on its left and Craven on its right. Its length above New Berne, measured in a straight line, is about 150 miles, but it is much greater following the river, which is very tortuous in places. The principal towns on the stream are New Berne (population 6,443), Kinston (population 1,216), Goldsboro' (population 1,933), Smithfield, and Hillsboro', the last being on the Eno. The head of navigation on the river is Smithfield, about 160 miles above New Berne, and the government is now engaged in improving the river up to this point. At present there is a navigable depth of 3 feet as far as Goldsboro' (97½ miles above New Berne) during eight or nine months of the year.

The area drained by the Neuse comprises about 5,300 square miles. That part above New Berne measures about 4,250 square miles. The principal tributaries of the river enter from the north, viz: the Contentnea creek (mouth about 30 miles above New Berne) and Little river (mouth just above Goldsboro', 97½ miles above New Berne), draining, respectively, about 990 and 325 square miles, approximately. The river crosses the fall-line near Smithfield, and below that point there is no water-power. The fall at Smithfield, however, is not very great, and the fall-line is less prominent than in the case of the Roanoke and the Tar, the ledge of rock, forming the falls at Weldon and Rocky Mount, showing itself only very slightly on the Neuse.

Below Goldsboro' the river flows through a low, heavily-timbered country, and is very like the Roanoke in general character. The soil is alluvial—clay, sand, and marl; the banks from 3 to 20 feet high; the country covered with extensive pine forests and cypress swamps, and the staple product cotton. Some of the bottoms have been reclaimed by the use of dikes. Below Contentnea creek the banks and adjacent bottoms are only a few inches above low water, and the floods reach a height of 12 feet, covering large areas. The channel is very tortuous, cut-offs are often formed, and the navigation difficult. Above Smithfield the drainage-basin presents no peculiarities that have not been referred to in speaking of the Roanoke and Tar. The map will show its form and dimensions.

In the upper part of the valley a fine quality of granite is quarried, and in the lower part, not far above New Berne, a marl is found which is said to be a very good building-stone, being quite soft when quarried, but becoming very hard on exposure. In fact, there is no lack of building material in the valleys of the Neuse, Tar, or Roanoke.

As regards bed, banks, and freshets, the river is similar to the Roanoke, except that the bottoms are said to be less extensive (above Smithfield) and the freshets not so sudden nor violent, seldom endangering dams. Trouble with ice is very rare. There are no lakes or artificial reservoirs, but there are facilities for the latter on the upper tributaries.

The rainfall is 47 inches—12 in spring, 14 in summer, 10 in autumn, and 11 in winter, approximately.

The fall of the river below Smithfield is very small, its elevation at that point being in the neighborhood of 100 feet. At the crossing of the Raleigh and Gaston railroad, some 35 miles farther up, the elevation is about 170 feet, making the fall between those points at the rate of 2 feet to the mile. Professor Kerr states that the total fall, from the northwest corner of Wake county, about 32 miles above the railroad crossing, to tide, is about 340 feet; it seems, however, scarcely probable that the fall in these 32 miles can be at the rate of 5.3 feet to the mile.

WATER-POWERS.

The first site for power in ascending the river is at Smithfield, at the fall-line, and it is said that there was once a mill there, although it is now gone. Although some power might be obtained at the place, the site is not a favorable one. The river at Smithfield is 130 feet wide.

The next site, and the first one of importance, is at Milburny or Neuse mills, about 25 miles above Smithfield and 6 or 7 miles from Raleigh, formerly improved, but at present idle. The available fall here is about 12½ feet, with a dam 8 feet high and a race 150 feet long. Such a dam, it is said, would pond the water for several miles. It is evident, therefore, that the fall here is not very pronounced, and it seems strange that there is no large fall on the river below this point. It seems probable, moreover, that power might be got below by damming, but it is said that there are no favorable places where a dam could be built without trouble by overflowing land above. At Milburny the bed is solid rock, very favorable for a dam, and the race had to be blasted out. The banks are abrupt on the right, but not so much so on the left, and the location is said to be a safe one. The power was formerly used by a paper-mill on the left bank and a grist- and saw-mill on the other, the fall utilized being 12½ feet; but the paper-mill was burnt, and the dam, not being taken care of, is gone. The building of the grist- and saw-mill is still standing, although it is about five years since any power has been utilized. It is expected, however, that the power will be again utilized in a short time.

The drainage area above this site is about 1,000 square miles. Professor Kerr gauged the river at low water, and found the flow to be about 193 cubic feet per second, giving a power of 22 horse-power per foot fall. Estimates of the flow and power, according to methods already referred to, result as follows:

State of flow (see pages 18 to 21).	Drainage area.	Fall.	Flow, per second.	Horse-power, gross.	Horse-power, gross.
	Sq. miles.	*Feet.*	*Cubic feet.*	*Per foot fall.*	*Per 12½ feet fall.*
Minimum	1,000	12½	160	18.2	227
Minimum low season			175	20.0	250
Maximum, with storage			750	85.2	1,065
Low season, dry years			190	21.8	272
"Low water", Professor Kerr			193	22.0	275

By storing the water during the night this power could be greatly increased, but whether such storage would be practicable, I cannot say, not knowing the dimensions of the pond.

This power, as before remarked, is 6 or 7 miles from Raleigh, from which point railroads diverge in four directions.

The next power on the river is the paper-mill of the Falls of Neuse Manufacturing Company, leased to W. F. Askew. Between this power and Milburny there was formerly an oil-mill, but the dam is said to have caused so much trouble by overflow, and so much sickness in the vicinity, that the property was purchased by the neighbors, and the mill torn down. Mr. Askew's paper-mill is at Falls of Neuse, 3 miles above the Raleigh and Gaston railroad, and 13 miles north of Raleigh. The dam, which extends entirely across the river, is of wood, about 400 feet long and 6 feet high, backing the water about 10 miles, the depth averaging perhaps 8 feet. A race 1,000 feet long leads to the mill, where there is a fall of 17 feet. The power used is 100 horse-power, used for the paper-mill and for a grist-mill, saw-mill, and cotton-gin, but this power can only be obtained during eight months of the year, owing to leakage, etc. There is little trouble with high water.

The drainage area above this place is about 890 square miles, and the rainfall 42 to 44 inches. Hence the power available, per foot, would be about eight-tenths of that at Milburny, or, in round numbers, as given in the following table:

*Table of power at Falls of Neuse.**

State of flow.	Drainage area.	Fall.	Flow, per second.	Horse-power.	Horse-power.
	Sq. miles.	*Feet.*	*Cubic feet.*	*Per foot fall.*	*Per 17 feet fall.*
Minimum			128	14.5	245
Minimum low season	890	17	140	15.9	270
Maximum, with storage			665	75.5	1,283
Low season, dry years			152	17.2	292

Above this mill there are no powers of importance on the river so far as I could learn. It seems strange that such a large and long river should offer so little power, especially in a section of country which abounds so largely in water-power. The fact that there is no power on the fall-line is also remarkable.

The following table gives a summary of the powers on the river utilized and available:

Neuse River—Summary of power.

Locality.	Distance from head of navigation.	Drainage area.	Rainfall. Spring.	Rainfall. Summer.	Rainfall. Autumn.	Rainfall. Winter.	Rainfall. Year.	Total fall. Height.	Total fall. Length.	Horse-power available, gross.† Minimum.	Horse-power available, gross.† Minimum low season.	Horse-power available, gross.† Maximum, with storage.	Horse-power available, gross.† Low season, dry years.	Total utilized. Fall.	Total utilized. Horse-power, net.	Per centum of minimum utilized.
	Miles.	*Sq. m.*	*In.*	*In.*	*In.*	*In.*	*In.*	*Feet.*	*Miles.*					*Feet.*		
Milburny	25	1,000						12½	......	227	250	1,065	272	0	0	0
Falls of Neuse	38	890						17	......	245	270	1,283	292	17	100	65
Between Raleigh and Gaston railroad	35	900	11	13	10	10	44									
and								70	35	1,400*	1,540*	6,550*	1,680*	0	0	0
Smithfield	0	1,317														

* Practically of no value, and, in fact, not available.

† See pages 18 to 21.

TRIBUTARIES OF THE NEUSE RIVER.

Most of the utilized power in the drainage-basin of the Neuse is located on its tributaries, although none of them are large enough to afford very large powers.

The first important one met with in ascending the Neuse is the Trent river, which joins the Neuse at New Berne. The drainage-basin of the Trent, lying entirely below the fall-line and presenting no water-power of importance, need not be further considered.

The next important tributary is Contentnea creek, from the north, draining an area of about 990 square miles, and joining the Neuse about 30 miles above New Berne. This stream has its sources above the fall-line, in Franklin county, where it is called Moccasin creek; thence, flowing in a southeasterly direction, it forms the boundary-line between Franklin and Nash counties on the north and Wake and Johnston on the south, flows through Wilson and Greene counties, and finally joins the Neuse, after forming for 6 or 7 miles the boundary between Pitt and Lenoir counties. It crosses the fall-line, in Wilson county, about at the point where it changes its name to Contentnea; but, as in the case of the Neuse, there seems to be no decided fall in the stream at this point. Above the fall-line it partakes of the general character of Swift and Fishing creeks, previously described, and it affords no water-power of much importance, the declivity being gradual. There is probably power available on the stream which can be utilized by damming at suitable places, but no particular sites for powers were brought to my notice. The tributaries of the Contentnea are not of much importance.

The next important tributary is Little river, which rises in Franklin, flows southeast through Wake and Johnston, joining the Neuse in Wayne county 2 or 3 miles above Goldsboro', and draining an area of about 325 square miles, the length of the stream, in a straight line, being nearly 60 miles. The drainage-basin is long and narrow, and the

* See pages 18 to 21. According to all I can learn regarding this power, I am inclined to regard these estimates as too large, being informed that it is sometimes only possible to run a grist-mill in summer for several weeks at a time. But the dam is very leaky, and it may be that there are other sources of loss. Only an examination of the place can tell.

tributaries of no consequence. The stream crosses the fall-line, but, as in the case of the Neuse, no particular fall occurs at that place. The products of the basin are principally corn, cotton, cereals, vegetables, and fruits, and the soil fertile, generally sandy and loamy. The general character of the stream does not differ from that of the tributaries of the Tar. The banks are often low and subject to overflow, and the bed is generally of soft material—mud, sand, etc. The declivity is quite uniform, and no important sites for power could be learned of. There is some power already utilized, the most important mill being the cotton factory of William Edgerton, at Lowell, about where the stream crosses the fall-line, and some 25 miles from its mouth. The power at this place is supplied by a wooden dam, built some thirty-three years ago, about 80 feet long and 10 feet high, backing the water 4 miles, with an average width of 150 feet and an average depth of 6 feet. The fall used is 10 feet, and the number of horse-power 40, which can be obtained at all seasons of the year. The drainage area above the place being about 195 square miles, and the rainfall about 48 inches, I have estimated the minimum and the low-season flow in dry years at about 18 and 25 cubic feet per second, respectively, and the available power, with a fall of 10 feet, at 20 and 28 horse-power. With storage during the night these figures could be increased, and this may easily be done if the pond is as large as given above. Above the Lowell factory, on Little river, are only small saw- and grist-mills. The water-power of the stream may be said to be, in general, of little value.

In the neighborhood of Goldsboro' there are several small spring streams which are said to afford quite constant powers, but none of them have sufficient capacity to run any but very small mills. Such are Sleepy creek (mouth 10 miles below Goldsboro') and Falling creek (mouth 10 miles above the railroad bridge). On these streams large storage can generally be obtained, and the power resulting from the natural flow could be doubled by being concentrated into twelve hours.

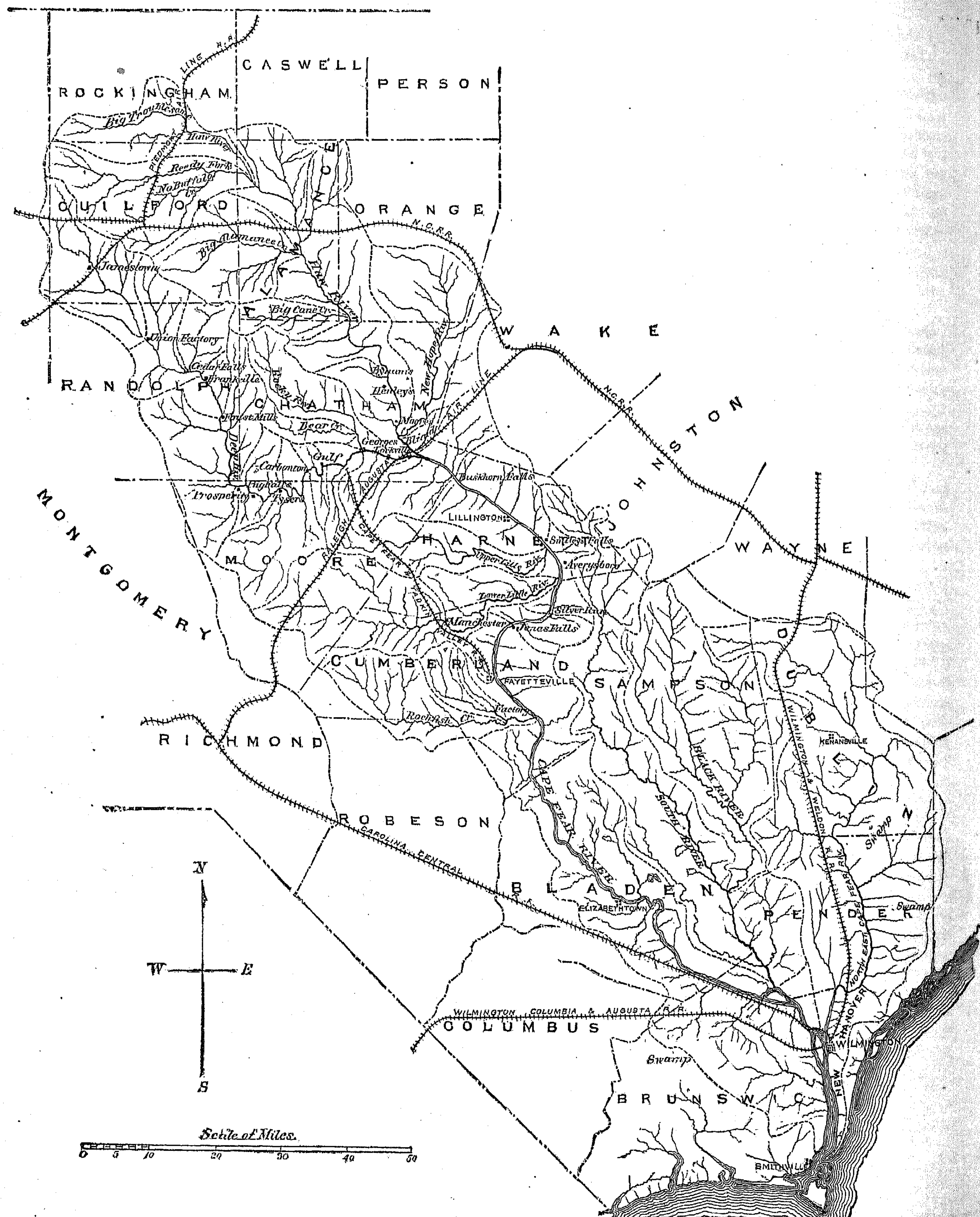
The other tributaries of the Neuse below the junction of its three headwaters have numerous small grist- and saw-mills and occasionally a paper-mill, all of which are here tabulated. Most of these mills have to stop during the summer on account of low water.

The most northerly of the three headwaters referred to is the Flat river, which rises in Person county and flows southeast through a corner of Orange, having a total length of some 25 miles in a straight line. It drains an area of about 166 square miles, being the largest of the three streams, has a considerable fall, and is well suited for the development of small powers. The power utilized is given in the table. The power available I cannot estimate; neither could I obtain information regarding any particular sites not used.

Little river is the second of the three headwaters. Rising in Orange county, with perhaps a few branches in Person, and flowing a little south of east through the northern part of Orange, with a total length, in a straight line, of some 20 miles, it drains an area of about 130 square miles. None of these streams are very tortuous. Little river has the same general character as Flat river, and its power is utilized by saw- and grist-mills, and by one cotton factory—the Orange factory. The power at this place is obtained by a dam of stone and wood, 270 feet long and 14 feet high, built at a cost of $1,500, and affording a fall, at the factory, of 17½ feet and furnishing a 40 horse-power. In summer there is no waste of water, but in winter it generally flows over the dam. I estimate the flow of this stream at its mouth to be at a minimum about 8, and at its low-season flow, in dry years, 12 cubic feet per second, giving powers of 16 and 24 horse-power, with fall of 17½ feet. I judge, therefore, that the pond at Orange factory is sufficiently large to store the water during the night if they succeed in getting full capacity all the time. The above estimate, however, may, of course, be far from correct.

The most southerly of the three headwaters of the Neuse is the Eno, rising in the northwest corner of Orange county, flowing first nearly south and then nearly east through the county, having a length of about 25 miles in a straight line, and draining an area of about 134 square miles. It is similar in character to the others, and its power is used only by grist- and saw-mills, some of which are obliged to stop in the summer. At Hillsboro' the stream is about 50 feet wide, and will probably afford not more than 8 or 9 cubic feet per second in dry years during the low season, and probably less, or about 1 horse-power per foot fall. The utilized power is given in the table.

It will be seen that the Neuse river possesses a small amount of water-power for a stream of its size in this part of the country. The lower parts of the river and the tributaries below the Raleigh and Gaston railroad are not very favorable for power—the river on account of its gradual fall and low bank, and the tributaries because of the considerable variability in their flow. Exceptions are found in the case of some tributaries not far below the fall-line, which are fed by springs and keep up quite well during the summer, belonging, in fact, to the class of sand-hill streams, of which we shall meet more noticeable examples in the case of the tributaries to the Cape Fear and Yadkin. The tributaries in the upper part are more favorable, have a greater fall, higher banks, and are probably not so variable in their flow. Still, there are no such sites for power on the Neuse river as are found on the Roanoke, Tar, or on streams farther south.



CASWELL
PERSON
ROCKINGHAM
GUILFORD
ORANGE
N.C.R.R.
Jamestown
Big Cane Cr.
WAKE
Union Factory
Cedar Falls
Franklinsville
RANDOLPH
CHATHAM
Haw River
New Hope Riv.
Henley's
Georges
Lockville
Buckhorn Falls
JOHNSTON
MONTGOMERY
Carbonton
Gulf
Prosperity
LILLINGTON
HARNETT
WAYNE
MOORE
Averysboro
Upper Little Riv.
Lower Little Riv.
Silver Run
Manchester
Jones Falls
CUMBERLAND
FAYETTEVILLE
SAMPSON
DUPLIN
KENANSVILLE
RICHMOND
Rockfish Cr.
CAPE FEAR RIVER
BLACK RIVER
SOUTH RIVER
ROBESON
CAROLINA CENTRAL
BLADEN
ELIZABETHTOWN
PENDER
Swamp
WILMINGTON & WELDON R.R.
NORTH EAST CAPE FEAR RIV.
NEW HANOVER
WILMINGTON, COLUMBIA & AUGUSTA R.R.
COLUMBUS
WILMINGTON
BRUNSWICK
SMITHVILLE
N
W
E
S
Scale of Miles.
0 5 10 20 30 40 50

Neuse river and tributaries—Table of power utilized.

Name of stream.	Tributary to what.	State.	County.	Kind of mill.	No. of mills.	Total fall used.	Total horse-power used, net.
						Feet.	
Neuse river	Pamlico sound	North Carolina	Wake	Paper	1	17	80
Do	do	do	do	Flour and grist	1	10	20
Do	do	do	do	do	1	8	20
Contentnea creek (Moccasin)	Neuse river	do	Wilson	do	3	23	79
Do	do	do	do	Saw	2	16	60
Do	do	do	do	Cotton-gin	1	6	8
Do	do	do	Johnston	Flour and grist	2	17	107
Do	do	do	do	Saw	1	12	70
All tributaries to	Contentnea creek	do	Greene	Flour and grist	6	63	145
Do	do	do	Wilson	do	6	43	100
Do	do	do	do	Saw	2	16	45
Do	do	do	do	Cotton-gin	8	32	48
Do	do	do	Wayne	Flour and grist	2	17	12
Do	do	do	do	Saw	1	8	18
Do	do	do	Nash	Flour and grist	2	......	22
Do	do	do	do	Saw	2	......	22
Little river	Neuse river	do	Johnston	Flour and grist	2	14	77
Do	do	do	do	Saw	2	16	40
Do	do	do	do	Cotton factory	1	10	40
Do	do	do	Wake	Saw	1	14	16
All other tributaries to	do	do	Wayne	Flour and grist	4	50	120
Do	do	do	do	Saw	1	10	10
Do	do	do	do	Woolen	2	......	......
Do	do	do	Johnston	Agricult'l implements	1	8	20
Do	do	do	do	Flour and grist	13	133	206
Do	do	do	do	Saw	3	39	36
Do	do	do	Pamlico	Flour and grist	1	8	20
Do	do	do	Jones	do	3	39	70
Do	do	do	Craven	do	1	8	4
Do	do	do	do	Cotton-gin	1	......	......
Do	do	do	Lenoir	Flour and grist	3	27	86
Do	lo	do	Wake	do	23	309	397
Do	do	do	do	Saw	8	120	133
Do	do	do	do	Woolen	1	......	15
Do	do	do	Franklin	Flour and grist	1	20	15
Do	do	do	Granville	do	3	49	72
Do	do	do	do	Saw	1	18	30
Flat river and tributaries	do	do	Orange	Flour and grist	4	50	100
Do	do	do	do	Saw	1	12	20
Do	do	do	Person	do	5	61	145
Do	do	do	do	do	5	......	125
Little river and tributaries	do	do	Orange	do	4	55	48
Do	do	do	do	do	6	86	90
Do	do	do	do	Box	1	......	6
Do	do	do	do	Cotton factory	1	17	40
Eno river and tributaries	do	do	do	Flour and grist	18	271	358
Do	do	do	do	Saw	4	60	55

V.—THE CAPE FEAR RIVER AND TRIBUTARIES.

THE CAPE FEAR RIVER.

This river, formed by the junction of the Haw and Deep rivers in Chatham county, North Carolina, flows in a southeasterly direction through Harnett, Cumberland, Bladen, and Brunswick counties, and for a short distance between Brunswick and New Hanover, and empties into the Atlantic at Cape Fear. Its length, in a straight line, is about 125 miles, and by the river about 192. The principal towns on the stream are Wilmington, 30 miles from the mouth (population 17,361); Elizabeth, the county-seat of Bladen county; Fayetteville, the county-seat of Cumberland county (population 3,485); Averysboro', and Lillington (the county-seat of Harnett county)—the two latter being small towns of a few hundred inhabitants. Fayetteville is the head of navigation for steamers of light draft, its distance from the sea being 160 miles by the course of the stream. Considerable money has been, and is being, spent by the government for the improvement of the navigation of the river below Wilmington, which is a port of the entry, and present project contemplates the securing of a navigable depth of 12 feet at mean low water up to