REPORTS ON THE WATER-POWER

OF

THE HUDSON RIVER BASIN

AND THE

LAKE GEORGE OUTLET,

BY

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335—i

TABLE OF CONTENTS.

LAKE GEORGE OUTLET.

LIST OF ILLUSTRATIONS.

LETTER OF TRANSMITTAL.

BOSTON, MASS., *July* 9, 1883.

Professor W. P. TROWBRIDGE,

Columbia College, New York City.

SIR: I have the honor to submit a report upon the water-power of the Hudson River basin, based upon investigations carried on under your direction, mainly in the autumn of 1882. A short report upon the water-power at the outlet of lake George is also appended. It is desired to call attention to the principles observed in the estimates of flow and power, which are fully explained in connection with the report on the region tributary to Long Island sound.

Very respectfully,

DWIGHT PORTER,

Special Agent.

339—v

REPORT

ON THE

WATER-POWER OF THE HUDSON RIVER BASIN.

THE HUDSON RIVER BASIN.

GENERAL DESCRIPTION OF THE HUDSON RIVER AND OF THE REGION TRIBUTARY ABOVE TROY.

In the elevated mountain region of Essex county, in northeastern New York, are the principal sources of this important river. It takes a rather irregular southerly course till on the northern boundary of Saratoga county it turns abruptly to the eastward for a dozen miles or so by general course, and cuts its way through the mountains, forming, as it strikes across the rocky strata, several falls of great height and beauty. At Sandy Hill there is another quick turn, even more sudden than the previous one, and the direction of flow then continues southerly till the river empties into New York bay.

In its upper waters the Hudson is formed by a number of branches heading at points about equally remote from the mouth of the Sacondaga, and it is perhaps not easy to say that the main river has its origin with any one of these to the exclusion of the others; but if we assume the true head to be in the highest collected and permanent body of water, then the source of the Hudson river becomes lake Tear-of-the-Clouds, which lies at an elevation of 4,322 feet above tide, in the center of the triangle formed by mounts Marcy and Skylight and Gray peak, and the discovery of which source is claimed by Verplanck Colvin, superintendent of the Adirondack survey. From this lake to the mouth of the river the distance by water is probably not far from 300 miles.

Table showing the fall in the Hudson river.

Locality.	Distance from mouth. (Above Fort Edward distances are by map measurement.)	Height of water-surface above mean sea-level.	Distance between points.	Fall between points.	Fall per mile between points.	Authority for elevations.
	Miles.	*Feet.*	*Miles.*	*Feet.*	*Feet.*	
Lake Tear-of-the-Clouds	300	4,322				Colvin, *Survey of the Adirondack Region.*
			34½	2,868	83.1	
Mouth of Cedar river	265½	1,454				Profile of the Adirondack Company's railroad. (*a*)
			1	51	51.0	
Mouth of Indian river	264½	1,403				Do.
			7½	269	35.9	
Mouth of Boreas river	257	1,134				Do.
			4½	93	20.7	
North River village	252½	1,041				Do.
			4½	60	13.3	
Mouth of North creek	248	981				Do.
			8½	164	19.3	
Mouth of Mill creek	239½	817				Do.
			3½	97	27.7	
The Glen	236	720				Do.
			8	126	15.7	
Mouth of Schroon river	228	594				Do.
			5½	23	4.0	
Mouth of Stony creek	222½	571				Do.
			6½	35	5.4	
Mouth of Sacondaga river	216	536				Do.
			19½	251.7	12.9	
Crest of Glens Falls feeder-dam	196½	284.3				(282.25 feet + mean low-tide at Albany. *b*) New York canal profiles. Clark.
			6½	166.2	25.6	
Fort Edward railroad bridge	190	118.1				(116 feet + tide. *c*) Samuel McElroy, survey made in 1866.
			10	16	1.6	
Crest of Saratoga dam	180	102.1				(100 feet + mean low-tide at Albany.) New York canal profiles.
			30	160	3.3	
Troy (mean low-tide)	150	2.1				Estimated from mean low-tide at Albany. (*d*)
			150	2.1	0.014	
Mouth of Hudson river	0	0				

a The elevations along the Adirondack Company's line were furnished by C. E. Durkee, superintendent.

b At the United States Coast Survey office mean low-tide at Albany is given as 2.07 feet above mean sea-level in New York harbor.

c The elevations given by Mr. McElroy refer, as nearly as can be judged, to mean low-tide at Troy, which is probably 2.1 to 2.2 feet above mean sea-level in New York harbor.

d By Coast Survey measurements mean tide at Albany is 4.84 feet, and mean low-tide 2.07 feet (as previously stated) above mean sea-level in New York harbor.

No special information can be given here as to the manner in which the fall of the upper river is distributed, other than that afforded by the table above. The fall is certainly very rapid, amounting to about 64 feet per mile

on the average from lake Tear-of-the-Clouds to North creek, in which distance the stream loses nearly 80 per cent. of its altitude above tide, descending 3,341 feet in say 52 miles. From the mouth of North creek to the mouth of the Sacondaga the descent is 445 feet in 32 miles, or nearly 14 feet per mile; it is neither uniform nor made up of sudden pitches, but is distributed among rapids which diminish in frequency as the Sacondaga is approached. Thence, in the 26 miles to Fort Edward, the river loses 418 feet more of its elevation, or an average of something over 16 feet to the mile, but of this, 175 feet is comprised within the three abrupt pitches at Palmer, Glens, and Baker's falls, while most of the remainder occurs in the rapids between Jessup's Landing and the Ox-bow above Glens Falls. From Fort Edward to Troy the fall is comparatively small, being but 116 feet in 40 miles, or 2.9 feet per mile. Below Troy the Hudson is a tidal river, with an oscillation at that point, due to tides, of about 2 feet, and a fall from mean low water at Albany to mean low tide at Governor's island of only 4.2 feet.(*a*)

From the mouth to the city of Hudson the river is navigable for first-class ocean vessels, and to Troy for vessels of less draught. The only important obstructions to ordinary navigation lie between New Baltimore and Troy, and in 1880 consisted of 14 bars, 5 above and 9 below Albany, with water depths of from 8 to 11 feet. Much work has been performed, both by the national government and by the state of New York, for the improvement of the river, and from June, 1866, to June, 1881, the former expended $900,000 for that purpose. In the upper part of the city of Troy the state has a dam, the first encountered on the river, through the pool of which canal-boats bound north ascend to Waterford, where they enter the Champlain canal. This follows up the west bank of the river to a point about 2 miles above Schuylerville, where it crosses in the pool of the Saratoga dam to the east side, on which it continues to Fort Edward; it then leaves the river, and striking to the northeast passes on to Whitehall, at the head of lake Champlain. There is thus afforded a water-transportation route about 400 miles in length, from New York city to the Saint Lawrence, the business of which is large and is said to be increasing. Except in connection with the canal to the slight extent mentioned, the Hudson is not employed for navigation above Troy. A portion of its upper course is rendered accessible by the Adirondack Company's railroad, which runs northerly from Saratoga Springs and follows the west bank of the river at present as far as North Creek.

Drainage areas of the Hudson river.

Locality.	Sq. miles.
Below the mouth of North creek	753
Below the mouth of Schroon river	1,457
Below the mouth of Sacondaga river	2,626
Palmer falls	2,650
Glens Falls	2,710
Champlain Canal crossing	2,904
Schuylerville, above Fish creek	3,360
Mechanicsville	4,476
Troy	8,034
Albany	8,200
Above the mouth of Rondout creek	10,500
Mouth of Hudson river	13,360

NOTE.– Drainage areas in the Hudson River basin have been measured by planimeter on French's map of New York.

Excepting that of the Delaware, the basin of the Hudson contains a greater population in proportion to its size than any other important river basin in the United States. According to the statistics of Mr. Henry Gannett, the aggregate number of inhabitants increased from about 1,964,000 in 1870, to 2,280,000 in 1880, or from an average of 148 to 172 per square mile.(*b*) This population is largely concentrated along the great highway of traffic which follows the valley of the Mohawk from the west and then continues down the lower Hudson. In the vicinity of Troy there is a dense settlement, comprising within the limits of that city, Cohoes, and the villages of West Troy and Lansingburg, about 92,000 inhabitants. Albany has 90,000, Poughkeepsie 20,000, Newburg, 18,000, Hudson 8,700; and all along the river between Albany and the mouth are scattered villages ranging from four or five thousand inhabitants downward, while surrounding the mouth of the river there is one great hive of population, including about 1,900,000 souls within the three cities of New York, Brooklyn, and Jersey City. Ascending above the mouth of the Mohawk there are met in turn the following principal villages on the main river: Waterford, 1,800 inhabitants; Mechanicsville, 1,300; Stillwater, 900; Schuylerville and Victory Mills, 2,700; Fort Edward, 3,000; Sandy Hill, 2,500, and Glens Falls, 4,900. Above Glens Falls the course of the river lies through the mountains, in a contracted and often extremely rugged valley, showing occasional small villages, but ill-suited to extensive settlement.

After cutting its way through the rocky barriers which obstruct its passage, in the last important instance at Sandy Hill, the Hudson settles peaceably down into its final southerly course and follows along that great

a Report of the Chief of Engineers U. S. Army, 1873, page 154.
b The drainage area being assumed slightly less than as given above.

depression which extends almost due north and south between New York bay and the Saint Lawrence, and which offers such splendid facilities for commerce. It now runs with clear blue waters through an open and charming valley, bordered by cultivated farms and thriving villages, for the location of which the topography is finely adapted, the country rising with moderate slope from the river to the summits of high hills. Descending 20 or 30 miles below Albany, the Catskill mountains rise boldly into view on the right, and thence to the mouth the immediate valley is flanked by hills of considerable height, the Highlands of Orange county, and, still farther south, the precipitous faces of the Palisades, forming especially noticeable features of scenery on the west side.

Although the Hudson drains a total area of 13,366 square miles, yet, so far as regards water-power on the main river, excepting the single case of the state dam at Troy, which is below the mouth of the Mohawk, there is to be considered only a tributary region of about 4,500 square miles. The southern portion of this is hilly, moderately wooded, well-settled, and devoted in the open country to the raising of grain, peas, beans, flax, and potatoes, to stock-raising, dairying, and wool-growing. But probably three-quarters of the area drained above the Mohawk is mountainous in character, heavily wooded in general, and dotted with numerous lakes and ponds. The elevated region seems to reach its culmination in Essex county, at the head-waters of the Hudson and Au Sable rivers. Of the three peaks which stand like sentinels about lake Tear-of-the-Clouds, the most elevated lakelet source of the Hudson, mount Marcy towers to a height of 5,344 feet above tide; mount Skylight, 4,890; and Gray peak, 4,902. The whole surrounding district is broken up by rugged mountain masses, a large number of peaks attaining altitudes of 3,000, 4,000, and in several instances nearly 5,000 feet. The rocks belong to the oldest formation, and are mainly granite, gneiss, and mica-schist; they contain extensive deposits of the most valuable magnetic iron ore.

Save the rocky summits of the higher mountain peaks and their more precipitous slopes, the whole region known as the "Northern Wilderness" was originally covered with magnificent forests of pine, spruce, and hemlock. To a large extent these still remain unbroken, but it is only in the remoter districts that this holds true, and elsewhere the lumbermen have made sad inroads. Although the forests are, for the sake of the lumber they furnish alone, a grand resource and have proved a mine of wealth to the state, yet in so far as concerns the river the operations of cutting and preparing the timber are from beginning to end prejudicial. In a region such as that which the upper Hudson drains, with its steep, rocky, and impervious slopes, either immense artificial reservoirs, or the natural reservoir and regulator afforded by a general covering of vegetation, are absolutely necessary to insure the constancy of the streams. Little regard, however, seems to be paid to any such consideration by those engaged in the business of lumbering. The trees are cut apparently without discrimination and the branches are left to cumber the ground. Forest fires become started and spread with great rapidity through the tinder-like material. The very soil is thus so parched and burned that it cannot renew its covering of vegetation, and the surface presents a most desolate and forbidding appearance. Robbed of the protecting mantle of the forests, the winter snows are exposed to the direct rays of the sun, and, instead of acting as conserving reservoirs, are liable to precipitate sudden and disastrous freshets in the streams to which they drain. The rains of the warmer seasons drain more quickly than before into the water-courses, the ground then speedily dries and the streams sink away. Thus a liability on the one hand to heavier freshets, and on the other to lower water, tends to increase those fluctuations of volume which were troublesome enough under natural conditions. Mr. Colvin states that "the burnt region on the Boreas river and upper Hudson alone covers an area of from 40,000 to 60,000 acres of rolling semi-mountainous lands; desolate with burnt, blackened logs; ghastly, barkless, dead timber standing, and a partial undergrowth of worthless birch, aspen, and alder brush".

In order to float the logs down stream advantage is taken of high water, which is artificially augmented and prolonged by "tripping", or drawing upon, certain of the lakes that have been dammed for this purpose. Having been drawn down, no further attention is paid to them for the season. They gradually fill up again, tend to hold back the needed summer supplies from the streams, and as thus managed are evidently entirely valueless as reservoirs, increasing, rather than reducing as they should, the extremes of high and low water. Nor do the disadvantages to which the Hudson is subjected at the hands of the lumbermen come to an end till the manufacture of the lumber has been finally completed. At various points along its course from Glens Falls down to the Saratoga dam immense numbers of logs are annually sawed and great quantities of sawdust and slabs are thrown into the river, the channel of which becomes thereby seriously clogged. The sawing season on the Hudson includes within its limits about eight months of the year, the winter not being availed of for that purpose, as it often is on the Connecticut; but for from two and one-half to three months out of the eight many of the mills are stopped, either partially or entirely, by low water. Glens Falls is the most important point on the river for this industry, but there are also large mills at Sandy Hill, Fort Edward, and near Schuylerville. No accurate statistics regarding the amount of lumber annually sawed on the Hudson are at hand; it varies widely in different years, but, judging from such figures as were stated by the mill-owners, it cannot fall far short, in an average year, of 90,000,000 of 100,000,000 feet at the nine or ten principal mills from the Glens Falls feeder-dam to the Saratoga dam.

Scarcely any recorded measurements exist of the discharge of the Hudson which have sufficient accuracy and definiteness regarding stage of water to be of great practical value in determining its water-power. The flow is artificially depleted at two points by withdrawals for feeding the Champlain canal. From above the village or Glens Falls a feeder opens from the river and follows down the left bank, striking the main canal to the southeast

of Sandy Hill. It is 7 miles long, and feeds both ways from the summit level of the canal—northward toward lake Champlain and southward down the Hudson valley—supplying water to about 23 miles of its length. October 1, 1878, a measurement was made to determine the amount withdrawn from the river by this feeder, which was found to be 234 cubic feet per second.(*a*) About 20 cubic feet per second of this is lost by leakage in the feeder, and is probably returned quite directly to the river. At Saratoga dam the river is again drawn upon to supply whatever water is necessary for the canal in the 24 miles thence to Waterford, where it opens out into the state pool in the Mohawk, opposite Cohoes. No statement as to the amount withdrawn at the Saratoga dam has been observed, but in his report upon the upper Hudson, Mr. Farrand N. Benedict estimates the total amount diverted for feeding-purposes above Waterford at about 330 cubic feet per second. (*b*)

At Palmer falls there is a favorable opportunity for determining the low-water discharge, and observations have been made at various times by Mr. Warren Curtis, superintendent of the Hudson River Pulp & Paper Company. Mr. Curtis states that the average low flow at that place, or for say the four months of least volume, is not far from 400 or 500 cubic feet per second, and that for one or two months it is not more than from 200 to 250 cubic feet per second. October 28, 1882, a measurement was made which indicated a discharge of about 390 cubic feet per second.

November 1, 1874, when the river was "almost at its minimum navigable stage", the volume was measured by Mr. Benedict at a point 1 mile above Waterford, and found to be 2,020 cubic feet per second. Estimating, as before said, 330 cubic feet to be diverted for feeding the Champlain canal, he considered the normal flow at the time to be 2,350 cubic feet per second.

In the report of the United States board of engineers concerning the improvement of the Hudson River navigation,(*c*) occurs the following remark:

> It seems that the discharge of the Hudson River water between Troy and Albany, at its low stage, is only about 2,000 cubic feet per second, the mean being about 10,000 cubic feet, while during freshets the wharf streets of the capital are flooded.

These various data may be thus summarized:

Data concerning the flow of the Hudson river.

Locality.	Stage of river.	Drainage area.	Flow per second.	Flow per second per square mile.	Remarks.
		Square miles.	*Cubic feet.*	*Cubic feet.*	
Palmer falls	Average flow for say four lowest months	2,650	400–500	0.151–0.189	Flow as estimated by Mr. Warren Curtis.
Do	Average flow for one or two lowest months		200–250	0.075–0.094	Do.
Do	October 28, 1882		390	0.147	Measurement by Mr. Curtis.
One mile above Waterford	River almost at minimum navigable stage	4,517	2,020	0.447	Actual discharge, as measured by F. N. Benedict of the United States.
Do	do		2,350	0.520	Normal estimated discharge, including 330 cubic feet per second withdrawn by feeders above.
Between Troy and Albany	Low water	About 8,100	2,000	0.247	Discharge as given in report of the United States board of engineers.

Mr. Benedict was of opinion that the annual rainfall on the upper basin of the Hudson is as great as 64 inches, although he assumed only 58 inches in his calculations for a reservoir system. Mr. Colvin employs an assumed rainfall of 40 inches in his estimates as to the capacities of the streams in this region, and considers that figure to be under the truth. There are no published records of rainfall observations in the Adirondack region sufficient to determine with any accuracy the annual precipitation. The Smithsonian tables embrace valuable data for a large number of stations immediately surrounding this section, but none in the interior. The results of observations at a few of these points are as follows:

Rainfall on the outskirts of the Adirondack region.

[From Smithsonian records.]

Locality.	County.	Elevation above tide.	Years of observation.	Spring.	Summer.	Autumn.	Winter.	Year.
		Feet.		*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
Plattsburg	Clinton	186	18	7.55	9.63	9.18	5.62	31.98
Potsdam	Saint Lawrence	394	20	6.20	10.15	8.38	3.90	28.63
Lowville	Lewis	846	23	6.96	10.04	9.09	7.46	33.55
South Trenton	Herkimer	835	10	12.82	14.78	13.25	13.05	53.90
Johnstown	Fulton	250	12	9.75	11.82	9.65	9.15	40.37
Granville	Washington	250	15	7.38	9.59	8.59	5.96	31.52

a Report of the Superintendent of Public Works for the year ending September 30, 1878, page 47. Of the 234 cubic feet per second, 126 was found to be wasting over weirs at various points along the canal, only 108 cubic feet being actually required for lockage, leakage, evaporation, etc.

b Report on a Survey of the Waters of the Upper Hudson and Raquette Rivers, 1874.

c Report of the Chief of Engineers U. S. Army, 1880.

If we take the average of observations for a dozen stations, forming a circuit about the district that is now under consideration, the rainfall is found to be about 8½ inches in spring, 11 in summer, 10 in autumn, 7½ in winter, and 37 for the year; but these amounts undoubtedly increase as the elevated country about the head-waters of the Hudson is approached.

Notwithstanding that the annual precipitation is of fair amount, and, as indicated above, is favorably distributed through the year, being greatest in the summer and autumn when the demands of evaporation are most heavy, still, if the data that have been given for flow are correct, it is evident that the low-water discharge of the river is quite small considering the nature and extent of country drained, apparently sinking to about 0.25 cubic foot per second per square mile of drainage area at and below the mouth of the Mohawk, and probably falling below 0.10 cubic foot at Palmer falls. The full explanation of this can only be surmised. It may be due in part to the steep and impervious character of the rocky drainage slopes in the mountains, in part, undoubtedly, to the clearing away of the timber, and in part to the slight extent to which the tributary lakes are availed of for keeping up the summer flow, their management for logging-purposes having, as has been seen, rather the reverse effect. It is not impossible, also, that there may be considerable loss of water at points through the rock substrata. The extensive leakage from the canal-feeder at Glens Falls illustrates how this might take place.

It is without question, however, that the low-water volume of the Hudson might be very greatly improved by the construction of reservoirs in its upper basin. The facilities for such works are unsurpassed. The entire region is dotted and interlaced by ponds and lakes, many of them of large size and fed from extensive drainage areas. It may be judged how numerous these are from the fact that although a great many are indicated on the state maps, yet in his report of 1874 the superintendent of the Adirondack survey announced the discovery of 200 ponds and lakes not before represented on maps. On the map of the upper waters of the Hudson and Raquette rivers, accompanying the report of Benedict's survey, not less than 175 ponds and lakes are shown tributary to the Hudson above Indian river, and the Raquette above and including Jordan river. All the principal affluents of the Hudson, at least above Troy, receive important accessions from lakes. In the absence of accurate and detailed maps it is not practicable to give special information here regarding most of these, but concerning the principal sheets of water available for reservoirs above Indian river reliable data have been afforded by the survey above referred to, and are briefly presented in the following table:

Principal reservoir sites at the head-waters of the Hudson river (above Indian river), as determined in a survey by Mr. Farrand N. Benedict in 1874.

Name of proposed reservoir.	Elevation above tide.	Drainage area.	Natural surface.	Flowage.	Total surface of reservoir.	Depth of reservoir.	Capacity.	Estimated supply per second for 100 days.	Estimated cost of dam.	Remarks.
	Feet.	*Sq. miles.*	*Acres.*	*Acres.*	*Acres.*	*Ft.*	*Cubic feet.*	*Cubic feet.*		
Blue Mountain lake	1,771	89.2	2,500	160	2,660	10	1,158,696,000	134	$7,800	Reservoir includes the three lakes, Utowana, Eagle, and Blue Mountain; lies naturally in Raquette basin, but via Long lake can be diverted to the upper Hudson. Estimated that winter and spring drainage would fill reservoir 1.87 time.
Raquette lake	1,745	94.1	5,300	1,500	6,800	10	2,779,128,000	321	6,000	Waters proposed to be diverted from Raquette river to Hudson. Estimated that winter and spring drainage will fill reservoir 1.87 time.
Forked lake	1,726	39.8	1,620	510	2,130	7	609,840,000	70	5,600	Waters to be diverted from Raquette to Hudson. Estimated that winter and spring drainage will fill reservoir 3.6 times.
Beach's lake	.....	8.6	640	160	800	8	250,905,600	29	2,100	Tributary to Forked lake. Estimated that winter and spring drainage will fill reservoir 1.88 time.
Long lake	1,614	155.4	3,000	4,575	7,575	20	5,912,834,400	684	a14,000	This lake naturally drains through the Raquette river, but, by cutting a canal across a low divide, can be connected with Round pond, and thus be made tributary to the Hudson. Estimated cost of bulkhead, canal, and outlet through slough at foot of lake, $154,600. Estimated that winter and spring drainage will fill reservoir 1.056 time.
Round pond	1,618	.....	.....	.....	640	10	278,784,000	32	.....	From Round pond to Catlin lake there is a fall of 35 feet in about 4,000 feet.
Catlin lake	1,583	31.1	1,040	500	1,540	18	815,443,200	94	22,000	Estimated that winter and spring drainage will fill reservoir 2.1 times.
Rich lake	1,549	67.1	600	400	1,000	20	609,840,000	70	28,600	Northern shore heavily wooded; southern cleared. Outlet narrow and rocky, with bold shores. Proposed dam would flow about 200 acres of improved land.
Harris lake	1,540		720	600	1,320	15	627,264,000	73	16,700	Estimated that winter and spring drainage will fill Rich and Harris Lake reservoirs about 3 times. Harris lake is the lowest member of a chain composed of those lakes mentioned above.
Lake Henderson	.....	.....	.....	.....	.....	12	209,088,000	24	5,800	
Newcomb lake	1,609	30.6	640	200	840	15	483,516,000	56	18,800	Estimated that winter and spring drainage will fill reservoir 3.5 times. This lake is surrounded by high mountains on every side except the east.

a Total cost of Long Lake improvement estimated by Mr. Benedict at $196,600.

Principal reservoir sites at the head-waters of the Hudson river (above Indian river), etc.—Continued.

Name of proposed reservoir.	Elevation above tide.	Drainage area.	Natural surface.	Flowage.	Total surface of reservoir.	Depth of reservoir.	Capacity.	Estimated supply per second for 100 days.	Estimated cost of dam.	Remarks.
	Feet.	*Sq. miles.*	*Acres.*	*Acres.*	*Acres.*	*Ft.*	*Cubic feet.*	*Cubic feet.*		
Lower Works reservoir	.....	57.2	.....	.....	2,000	15	1,306,800,000	151	$24,700	Estimated that winter and spring drainage will fill reservoir 2.4 times. Advantages for dam not so good as at some of the other sites. Includes lake Sandford.
Chain lakes	.....	14.9	1,680	300	1,980	10	862,488,000	100	6,000	Estimated that winter and spring drainage will lack 5 per cent. of filling the reservoir.
Goodenow pond	.....	0.25	320	.....	.....	6	83,635,200	10	7,900	Reservoir to be formed by dam on Goodenow river. Estimated that winter and spring drainage will fill reservoir 4.13 times.
Goodenow River reservoir.	.....	7.8	.....	480	.....	12	250,905,600	29	8,800	Reservoir to be formed by dam on Goodenow river. Estimated that winter and spring drainage will fill reservoir 1.72 time.
South pond	1,769	.....	.....	.....	.....	12	188,179,200	22	5,000	
Clear pond	1,691	.....	.....	.....	.....	10	217,800,000	25	7,000	Drain to Long lake.
Slim pond	.....	.....	.....	.....	.....	10	196,020,000	23	5,000	
Ackerman pond	.....	.....	.....	.....	.....	10	87,120,000	10	5,900	Tributary to Catlin chain of lakes.
Perch pond	.....	.....	.....	.....	.....	12	167,270,400	19	3,300	
Trout pond	.....	.....	.....	.....	.....	12	125,452,800	14	4,400	Drain through central or mountain branch of Hudson.
Lake Harkness	.....	.....	.....	.....	.....	12	104,544,000	12	3,100	
Shedd lake	.....	.....	.....	.....	.....	10	209,088,000	24	4,100	
First Sergeant pond	.....	.....	.....	.....	.....	10	87,120,000	10	3,900	Drain to Raquette lake.
Third Sergeant pond	.....	.....	.....	.....	.....	10	217,800,000	25	3,200	
Plumley pond	.....	.....	.....	.....	.....	11	258,746,400	30	4,100	
Moose pond	.....	.....	.....	.....	.....	11	182,080,800	21	5,500	Drain to Forked lake.
Cary pond	.....	.....	.....	.....	.....	10	139,392,000	16	4,772	
							18,419,781,600	2,128	*a* 229,172	

a Aggregate cost of improvements, including $14,800 for dam to control Little Tupper lake (designed in Mr. Benedict's plan to be used as a reserve for both the Hudson and Raquette rivers), and a total of $196,600 for Long lake, placed at $426,572.

It is thus seen that at an estimated expense of between $400,000 and $500,000 a probable supply of about 2,000 cubic feet per second from storage alone may be assured to the Hudson above the mouth of Indian river during three months or more of the dry season. It is a remarkable fact that, owing to the peculiar topography of the summit region about the adjacent sources of the Hudson and Raquette rivers, a reservoir capacity of over 10,000,000,000 cubic feet, properly belonging to the latter stream, may easily be diverted to the former. The particular reservoir sites that have been mentioned pertain to the extreme upper waters of the main Hudson, but upon all its principal tributaries below—the Cedar, Indian, Boreas, Schroon, and Sacondaga—there are abundant opportunities for extensive storage. In Mr. Benedict's report a list is given of 12 lakes and ponds in the Schroon River basin suitable for reservoirs, with an aggregate area of over 12,000 acres, a capacity of 5,900,000,000 cubic feet, and which are estimated capable of furnishing together a supply of at least 600 or 700 cubic feet per second during 100 days. Pisco lake, in the upper waters of the Sacondaga river, covering about 4 square miles, as represented on French's map, is controlled for log-driving purposes. Indian lake, tributary to Indian river, also having an area of 4 square miles,(*a*) is provided with a dam at the outlet, but the structure is poor and leaky, and the lake does not usually fill. Still, as it is, the water being held back longer than in most of the lakes, Indian lake affords, when "tripped" during the summer, about ten days of good sawing at Glens Falls. Although the building of reservoirs in the upper waters would benefit all the hydraulic powers on the course of the river below, it does not seem probable that their construction will be attempted by private capital. The mill-owners consider that the state would receive as much advantage from reservoirs, by reason of the improvement of low-water navigation below Troy, as any private interest would receive, and are not disposed to invest their own capital in such enterprises so long as there is a possibility that they may be undertaken as public works.

Above Glens Falls the largest tributaries of the Hudson are the Schroon and Sacondaga, the former entering from the east and the latter from the west. Between Glens Falls and Troy the Batten Kil and Hoosac river are received from the east and the Mohawk from the west. Below Albany the main river is joined from either side by numerous tributary creeks, of which the most important in point of drainage area is the Rondout.

The bed of the river above Troy is almost everywhere firm, and is generally composed either of solid rock at the surface, or of rock overlaid to a moderate depth by gravel. The banks are firm and of good height. The stream usually sinks lowest in August and September, and is regularly visited by freshets in the spring, with an occasional considerable rise in the fall. The flood heights above low water, as given in a report by Mr. Samuel McElroy,(*b*) range from 13 to 18 feet between Troy and Fort Edward, but it is reported on good authority that within

a By map accompanying Benedict's report.

b See *Annual Report of the State Engineer and Surveyor* for 1867.

the past 25 years there has been a rise of 22 feet below the Troy dam. Severe winter weather lowers the volume, but never to such a point as is reached in summer and fall. Anchor-ice runs heavily at times, and is especially complained of at Fort Miller. Gorges of cake-ice form at certain favorable points, as at Troy and Fort Miller, and cause considerable trouble by backwater.

The present use of water-power on the Hudson is confined to the localities of Troy, Stillwater, the Saratoga dam, Fort Miller, Fort Edward, Sandy Hill, Glens Falls, Palmer falls, and Hadley. Between Mechanicsville and Stillwater there is an old dam, but there was no power in use at the time it was visited. Opposite the upper part of the former village a fine privilege, commanding the flow from nearly 4,500 square miles of drainage area, has been developed, and a splendid dam of stone has been nearly completed. The manufacturing on the river by water-power is mainly limited to lumber, paper, and wood-pulp, to which the connection with the extensive forests in the north especially adapts it. Although below Glens Falls the available sites on the river are generally occupied, there is yet opportunity to establish an important power between Waterford and Mechanicsville, with probably 18 feet fall; immediately below the Saratoga dam there is an unimproved fall of perhaps 8 feet, and at Glens Falls one of 15 feet. Above Glens Falls, in its course through the mountains, the river is but slightly developed, and presents numerous sites that might be improved for power.

WATER-POWERS ON THE MAIN RIVER.

Power at Troy.—This privilege is located at the head of tide-water, the tide rising and falling 1 or 2 feet at the dam. There is navigation for steamers south 150 miles to New York, and a lock at the east end of the dam permits the passage of canal-boats to and from Waterford, at the entrance to the Champlain canal.

The dam runs across between the upper part of Troy, which is on the east bank, and Green Island, as it is called, on the west bank of the Hudson. It curves up stream slightly, and is 1,100 feet long, with a lift of 10 feet at low water. It is a log crib-work filled in with stone, and on top has a long slope of 30 or 35 feet down stream, ending in a vertical face a few feet in height; the sloping top, which serves also in part the purpose of an apron, is covered with round logs laid in the direction of flow. This dam was built by the state in 1826, and though frequently repaired since, the original structure still stands, but evidently permits a considerable leakage of water. It abuts against timber facing which on the east side is continued down past the mills. The nature of the filling opposite the dam, between it and the lock, is not apparent.

The principal use of power is on the Troy side. The hydraulic canal there opens from the pool a short distance above the lock and runs about 1,200 feet, approximately parallel to the river. In the upper portion this race is 60 feet wide, with a water-depth of 7 feet. For 700 feet from the head it is open; it then contracts, and the water passes through a 20-foot arched opening, in which it continues the rest of the way, the diameter of the opening growing less, however, toward the end. Near the head of the race there was once a wooden bulkhead, but it is now entirely in ruins and can not control the flow in the least. There is a waste-weir or some sort of escape in the lower part of the canal, but there being no head-gates it would of course be impossible to draw down the canal without building a coffer-dam.

When the state built the dam it reserved the right to all water necessary for lockage and slack-water navigation to Waterford, and leased the surplus. Previous to 1853 there were a cotton factory and a number of flouring-mills here, but they were destroyed by fire, and a decline in the flouring interest in this section prevented a continuance of that business. Power is now used on the east bank by five concerns. These are associated as the Troy Hydraulic Company, which has a lease directly from the state, for 999 years, of one-half the surplus water at this dam. Each mill-owner is a stockholder in the company, pays his water rental directly to it, and the company in turn pays to the state according to the terms of its lease. As the privilege was originally laid out, the hydraulic company owned 10½ lots lying between the canal and the river, each full lot having 60 feet frontage and an equal share to the water with every other lot. Every lessee therefore controls a proportion of water according to the number of lots which he owns, and the privilege comes to be divided as follows on the Troy side:

Orrs & Co., manufacturers of printing, book, and hanging papers, own five-elevenths.

Warren Brothers own two-elevenths, and sublet to Manning & Paine, manufacturers of manila paper.

George M. Tibbits' estate includes one-eleventh, the property being sublet to William Collins for a sash and blind factory.

John A. Manning owns two-elevenths, and uses the power in a manila paper-mill.

O. Boutwell & Son own one eleventh, and run a grist-mill.

Although the power is thus nominally divided, no measurement is ever made of the water actually used. The combined volume of the upper Hudson and the Mohawk flows past this point, but the use of water-power is nevertheless subjected to several disadvantages. The state will not allow the pool above the dam to be drawn down at all, as it is necessary to preserve sufficient depth for slack-water navigation to Waterford, and it thus happens that the mills on the Troy side are frequently called upon to shut down during low water. Taking the average for the year, it is claimed that a fall of about 7 feet is realized here. The extreme head available in low water is perhaps 3 or 4 inches over 10 feet, but on the whole the fall is very variable, being affected by three

causes: First, the tide produces a daily oscillation of 1 or 2 feet. Second, the fall is lessened, and sometimes entirely destroyed, by freshet backwater. In the past 25 years the extreme rise in the river below the dam, as stated by Mr. William Orr, has been 22 feet above low-water mark. The ordinary rise ranges from 12 to 20 feet and obliterates nearly all fall at the dam. Observation has shown that for every foot of rise above the dam there is about 2 feet of rise in the river below, so that when the water-surface reached a height of about 10 feet above the dam the river would be flowing smoothly over the structure. Very high water does not last more than a few days, but for a month the backwater is sufficient to cause more or less trouble. Third, the fall is similarly lessened by backwater due to ice-gorges. Below the dam the river is wide and contains extensive gravel flats. At various points on these flats, and sometimes against the bridge-piers between there and Albany, the ice collects and occasions serious trouble to the mills. The gorges do not seem to break up readily, as on most rivers, but at times cause a set-back in the river below the dam lasting for several weeks.

On the whole, it is estimated that in an average year the mills are forced to shut down for from four to six weeks from the various causes mentioned, and for a still longer period their power is somewhat curtailed. In 1873 the ice started down the river January 17, and from that time till February 5 no power was available at this privilege on account of a gorge below.

On the west side of the river the power is held under a perpetual lease from the state by the heirs of George M. Tibbits, deceased, who also own a valuable river frontage extending some distance down stream from the dam. A small amount of power is sublet to Crampton & Belden and M. L. Filley, manufacturers, respectively, of blinds and stoves, and the balance remains available for further lease. The race at this end of the dam is short, as the concerns noted above are close at hand. It is without any bulkhead, and in winter becomes choked with ice so as to give a great deal of trouble. As the power used is much less than on the Troy side, the mills are seldom shut down from low water, and there have been but one or two such occurrences in ten years. In 1880 a total of about 1,300 horse-power was in use at the state dam, including the privileges on both sides of the river.

From Troy to Mechanicsville.—Ascending from Troy, the river is found to be between 700 and 800 feet wide at Waterford bridge, and is there subject to an ordinary spring-freshet rise of 6 or 8 feet, while in the fall of 1868 or 1869 it rose 15 feet. About a mile above Waterford there is a long rocky shoal, and another from 2 to 2½ miles below Mechanicsville. Opposite this latter shoal the west bank is 15 or 20 feet high and succeeded by level land; the east bank is lower, and beyond it is a meadow perhaps a quarter of a mile in width. Generally speaking, the river between Waterford and Mechanicsville is wide and much of the way shallow, and contains a number of islands rocky and timbered. This portion of the river is of importance, as it is considered that still another power, at least equal in capacity to the fine one just improved at Mechanicsville, can be established. The results of McElroy's survey indicate a fall from the foot of Howland's dam above Mechanicsville to mean low-tide below the state dam at Troy of 61.75 feet in a distance of 13½ miles. If we allow 4 feet of unimproved fall between Howland's dam and slack-water from the new dam below, 16 feet fall to the Mechanicsville power, and 10 feet to that at Troy, there remains 31.75 feet undeveloped in the section below Mechanicsville. A certain part of this is necessary for the flow of the river; but it seems probable that if the banks prove of sufficient height a fall of 18 feet, which is the amount said to be claimed for the proposed privilege, could be obtained without difficulty.

Estimate of power available between Troy and Mechanicsville.

Stage of river.	RAINFALL ON BASIN.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		
	Spring.	Summer.	Autumn.	Winter.	Year.					
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	*1 foot fall.*	*18 feet fall.*	*30 feet fall.*
Low water, dry year	9	12	10½	8	39½	4,500±	900	102.24	1,840	3,070
Low water, average year							1,000	113.60	2,040	3,410
Available 10 months, average year							1,600	181.76	3,270	5,450

Power at Mechanicsville.—The development of the privilege now to be described, by the Hudson River Water Power & Paper Company, was carried on during the year 1882, and by the latter part of October of that year had been far advanced. The prime movers in the enterprise were Messrs. Wilkinson Brothers & Co., of New York city, who are also the principal shareholders.

The location chosen is immediately above the village of Mechanicsville, where the river is crossed by rock ledges and has banks firm and of good height on each side. On the west the land has a gentle slope beyond the immediate bank, while on the east the rise from the river is succeeded by a level meadow. Rocky shoals extend some distance up stream, and also run somewhat below the dam, but the latter is near their foot, and no material fall is gained beyond its height. An excavation for the east end of the dam showed the bank there to be composed of shale to within a few feet of the surface, and then of a light sandy soil. The structure rests throughout upon slate rock which is full of seams. The seams are not open, however, so as to permit leakage under the dam; at least

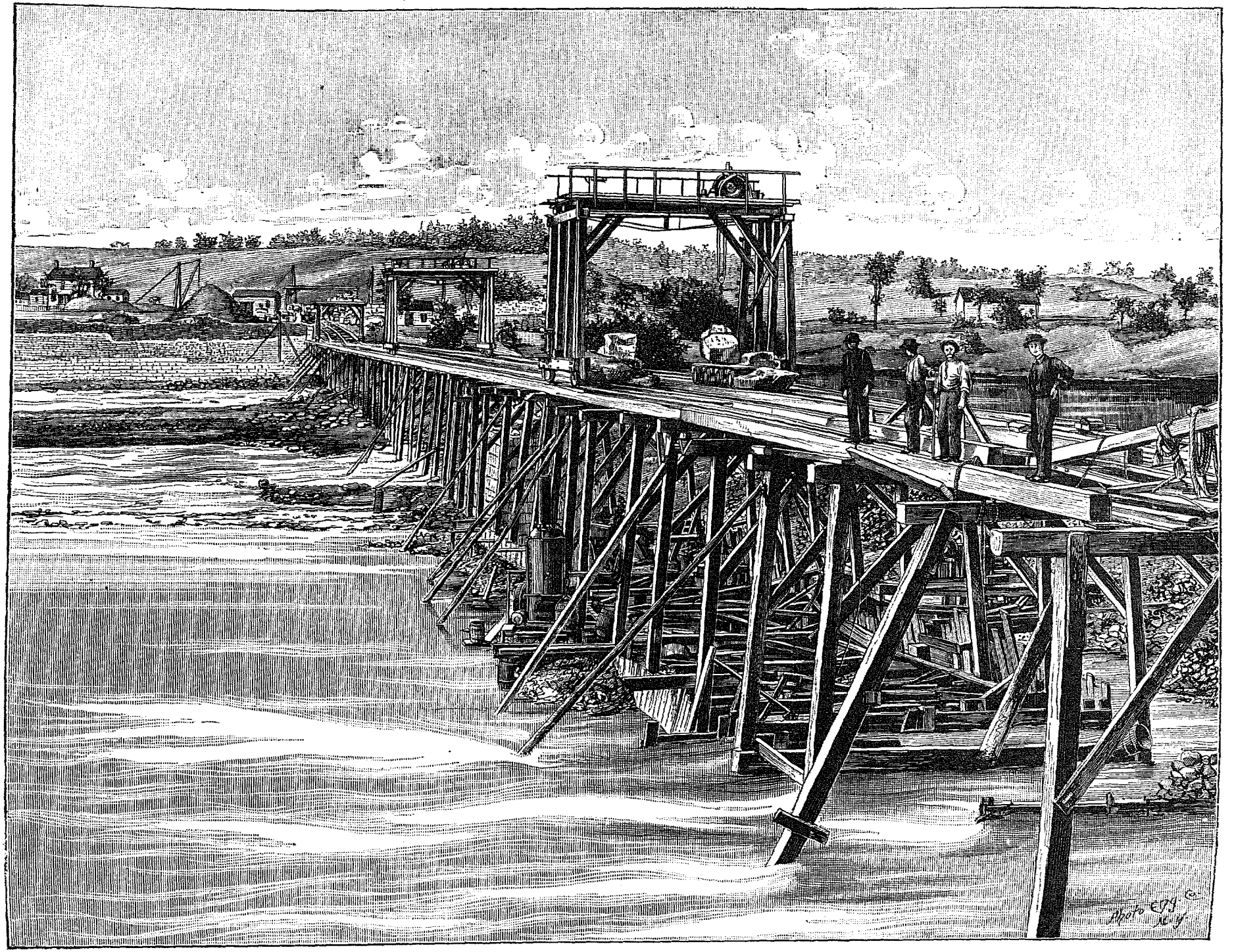

FIG. 1.—New dam at Mechanicsville during construction.

no leakage had been perceptible under a head of 6 or 8 feet, and it was not anticipated that there would be any. The slate remains compact and firm so long as under water, but upon exposure to the air crumbles into fine flakes and splinters, and finally forms a clayey soil.

The facilities for constructing a dam at this locality were excellent. The Champlain canal runs along the west bank but a few hundred feet from the river, and a temporary tramway was extended directly to the dam. So convenient were the arrangements, that it was possible to remove a stone from a canal-boat and lay it in position, 1,500 feet distant, at the farther end of the dam, in five minutes. A short distance beyond the Champlain canal is the line of the Boston, Hoosac Tunnel, and Western railroad. Close at hand is the village, well built up, with stores and churches, and having railway communication by two lines—the one just mentioned and that of the Delaware and Hudson Canal Company.

At the site of the dam the river was naturally of pretty uniform depth all the way across, ranging from 1 to 2 feet in low water; but there were two channels, one 6 feet deep and the other 9 or 10 feet deep and 40 or 50 feet in width. Across the latter channel the masonry has a total height of 25 feet and an equal width at base. For 7 or 8 feet down stream from the foot of the dam the river-bed has been blasted out to an average depth of 2 feet to receive an apron which will undoubtedly be added. The masonry work is all composed of a blue siliceous limestone obtained at Sandy Hill and brought by canal. The stone is said to answer well for rough work, but it is difficult to give it a fine finish. Sand was procured at Sandy Hill and at other points less remote, but little or none from the spot. For the lighter and more exposed work, such as the bulkhead piers, Portland cement was used, but for the main portion of the dam Rosendale cement was employed.

Construction work was begun at the west end; first the canal walls at that point were built, then the bulkhead was carried up till the capstones had been laid across the gate-openings, and afterward the dam was steadily extended toward the east shore. It was originally designed to complete it in 100-foot sections, but this plan was not followed; in fact, there was no especial system in this respect.

An important feature of the work was a railroad or tramway extending the whole length of the dam and used in transporting material. It was supported on bents placed about 12 feet apart. Each bent consisted of two upright posts, sloping inward slightly toward the top, with a capping piece and braces. The posts were 10 inches square, of spruce and pine, and the capping-pieces were 10 inches square or 10 by 12. The dam being 18 feet wide at the base, a clear space of 2 feet was left on either side to the bottoms of the posts; in other words, the latter were 22 feet apart. This system of trestle-work supported 6 iron rails; the 2 outer rails came about over the tops of the posts and served as a track for the "travelers", which will be described later, to move upon; between these was a double line of tracks for the gravity cars. From the Champlain canal to the river-bank, say 500 feet, there is a moderate descent, and still more down to the dam. The stone was unloaded from the canal-boats at a point opposite the end of the dam, a single line of track running down toward the latter and branching by a switch into a double track before reaching the edge of the bank. These tracks had a grade of about 10 feet in 300, but when fairly out upon the dam became level, and so continued the rest of the way across. The cars employed appeared to be common hand-cars fitted with a brake at one end. When loaded with stone or other material, one man operated the brake, and the grade of the inclined portion of the railway was sufficient to carry the car by its momentum to any portion of the work, even to the farther end of the dam. After being unloaded, the car was pushed back by hand to the foot of the incline and then hauled up by a rope.

The "travelers" were simply upright frame-works, consisting of a bent over each of the two rails on which they moved, with a platform at the top, and the whole suitably braced. The machine was given a motion along the track by a man standing on either side and working a cogged-wheel arrangement. From the platform overhead a stone was supported by chains and a transverse motion was obtained by men working on the platform. Two motions at right angles to each other were thus given, and a stone could be deposited at any desired point.

The coffer-work was not so expensive a feature in this dam as is often the case. For a portion of the distance a simple breastwork of chipped stone, blasted from the river-bed in the process of work, was made and puddled with clay on the up-stream surface. About 100 feet, mainly in the deep channels, consisted of timber crib-work filled in with loose stone and faced with sheet-piling, its upper surface puddled with clay. To a considerable extent the trestle-posts were also made use of in constructing coffer-work. Longitudinal pieces were fastened on their outer faces, and against these sheet-piling was driven; horizontal planking was secured to the inner faces of the posts, and the space between this planking and the sheet-piling filled in with clay. The trestle-posts were also used in the channel-ways, where, as has been said, crib-work was built, for supporting the cribs.

The front of the dam is rock-faced ashlar-work, and the coping is of cut stones 8 feet 10 inches long, sloping somewhat up stream. The ashlar courses range from 1 foot to 2½ feet in thickness, and are well bonded into the backing, which is rubble-work. From the crest to low-water surface at the foot of the dam the fall is 16 feet. The length of coping between abutments, that is, the length of roll-way, is 795½ feet. The total distance between abutments, including the bulkhead, is 928 feet. At the east end of the dam there was to be a supplementary embankment 500 feet long and 6 feet high next the river. The Mechanicsville dam has a base, in general, of about 18 feet, and has been so designed and constructed that if found desirable its height can be raised from 16, the

present figure, to 20 feet. The abutments rise 10 feet above the crest. That on the east side of the river extends from the upper base-line of the dam down stream to a point 20 feet below its face, and has two wings, each projecting 6 feet into the bank.

The bulkhead, which, as we have seen, is adjoining the west shore, is entirely of cut-stone masonry. It measures 20 feet in the direction of flow, and contains 12 gate-openings, each 10 feet high in the clear. Eleven of these have each a clear width of 7 feet 4 inches, and the remaining one is of half that width. The piers which separate them have each a minimum thickness of 2 feet, and a maximum, adjoining the gate recesses, of 32 inches. The gate-openings are rectangular in shape, and are controlled by wooden gates operated by a turbine, for which there is a wheel-pit in the abutment.

The canal running from the bulkhead is 115 feet wide in the clear, with a water-depth of 16 feet. It is formed by inclosing the part of the river next the west bank by masonry walls, and thus has for its bottom the natural bed of the river. The wall on the outer or river side is, for the first 150 feet below the dam, a waste-weir of the same height and construction as the dam, but with a base of 14 feet and with coping-stones 8 feet long. It contains two gates adjoining the dam, for drawing down the canal. From the end of this weir the river-wall was designed to be continued of the same dimensions as the former, but built entirely of rubble. The canal on this side was to be extended for the present 400 feet below the bulkhead. The water-power company owns land which will admit of giving it a total length of 1,000 feet, and it was stated as probable that an extension to nearly or quite that length would be made another season. This canal will closely follow the river-bank, the mills to be located on the inshore side discharging their tail-water in tunnels beneath the canal. The available fall is 16 feet.

The property of the company on this side of the river embraces 40 acres of land, and at the time it was visited extensive buildings were being erected for the manufacture of wood-pulp, with a productive capacity of 15 tons per day. The pulp-works were to have a river frontage of about 420 feet, and comprised buildings of the following dimensions: mills 60 by 170 feet, 50 by 136, 36 by 100, 25 by 48, 50 by 172, and 36 by 100; a boiler-house 42 by 50 feet, and a storehouse 40 by 160 feet. All of these buildings were to be two stories high on the river side, and some one story, some two stories on the shore front; they were being constructed of bricks made at the company's own kilns about a mile away.

It is planned ultimately to run a canal down the east bank also, in which case water would be taken out some little distance above the dam, the mills to be placed between the canal and the river. The company owns 110 acres of land on that side of the river, sufficient for extending the canal a quarter of a mile, and the topography is suitable for continuing it a much greater distance if desired.

The estimated cost of the dam, abutments, bulkhead, and canal-walls (including waste weir) for 400 feet in length had been $168,000, but it was stated by the treasurer of the company as probable that the actual expense would be slightly less than that amount. Some preliminary work was done in the latter part of May, 1882; the first stone was laid June 30, and by the latter part of October the dam had been completed except a short section adjoining the east shore, and the east abutment. The bulkhead on the west side had been carried up to include a single layer of stone covering the gate-openings, and the waste-weir with connecting river-wall was partially finished. It was expected that the whole of this work would be brought to a close by the middle of November. The construction had been prosecuted with a singular freedom from hinderances such as often embarrass similar undertakings. The only mishap encountered was the loss, during a September freshet, of a short section of trestle-work worth perhaps $1,500. The contractors for the work were Messrs. Smith & McGaw, of Philadelphia. About 75 men were usually employed on the dam. The working plant included 4 "travelers", 10 or 12 boom-derricks, and as many portable engines. For pumping, a No. 6 Andrews pump was employed, and also a cataract-pump.

The policy of the company regarding the use of this finely-developed power was stated not to have been fully determined upon, and it was undecided whether or not power should be rented to outside parties.

It is a difficult matter to make a reliable estimate of the power available at Mechanicsville. As has been elsewhere stated, no prolonged system of direct measurements of the flow of the river has been made at any point; the rainfall on the drainage basin is not known with much exactness, and but little is known, except by comparison with other streams, as to the ratio which drainage bears to rainfall in this basin, or its distribution through the year. In the prospectus of the water-power company, Mr. Peter Hogan, consulting engineer, certifies that the minimum discharge of the Hudson at the lowest stage of water of which there is any record amounts to 2,500 cubic feet per second for this locality. This certainly appears to be too high an estimate of the discharge. It is about 500 cubic feet more than was found by actual measurement 1 mile above Waterford by Mr. F. N. Benedict, November 1, 1874, and is an equal amount in excess of what has been assumed by the United States board of engineers as the combined low-water discharge of the upper Hudson and the Mohawk between Troy and Albany. If this privilege is to be utilized wholly for paper and pulp manufacture, in the processes of which mills run continuously throughout the 24 hours, then the storage above the dam, although useful in compensating for daily irregularities of flow, is not of special importance as otherwise increasing the available power. At all events, on account of the shoals extending steadily up stream from the dam, with rapid slope, the pondage is not large in comparison with

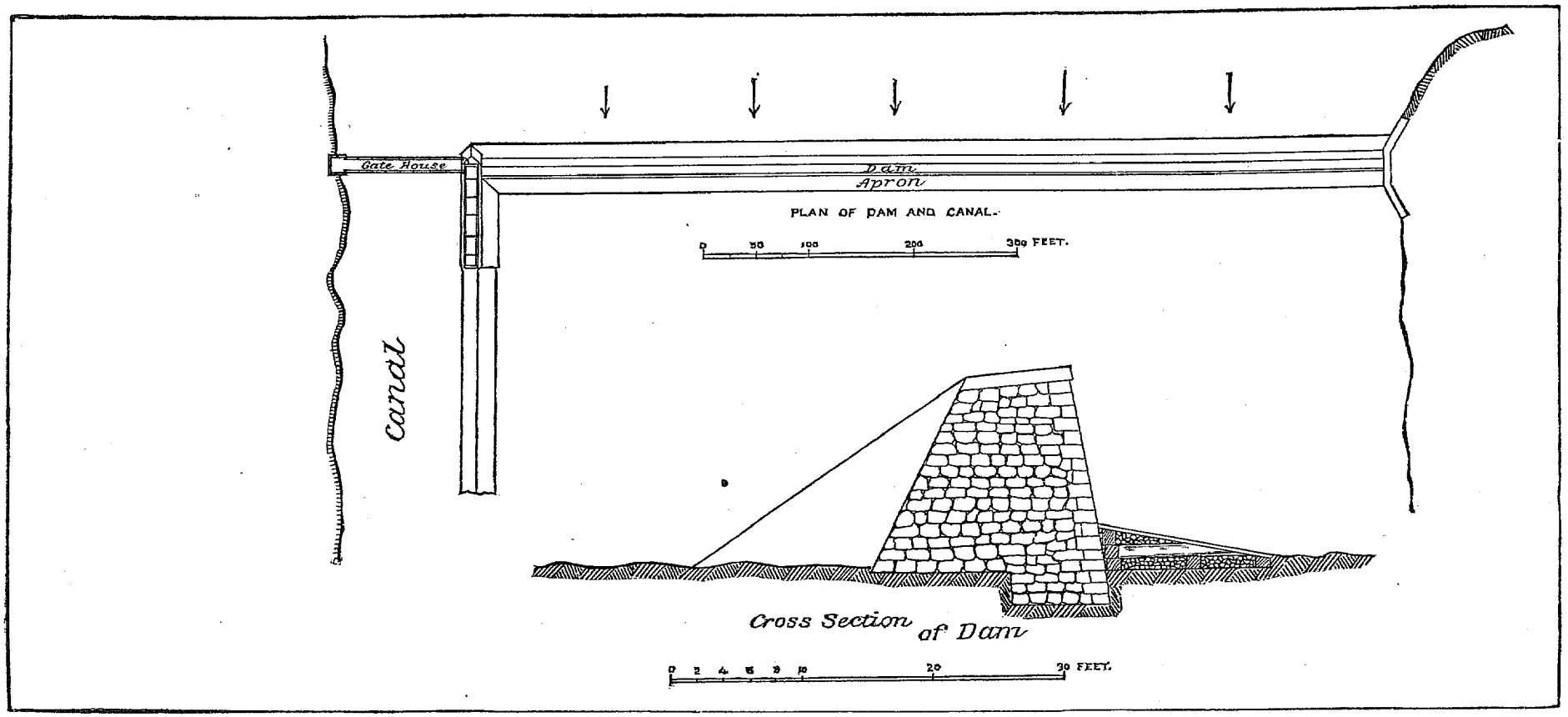

FIG. 2*a*.—Hudson River Water-Power and Paper Company's privilege.

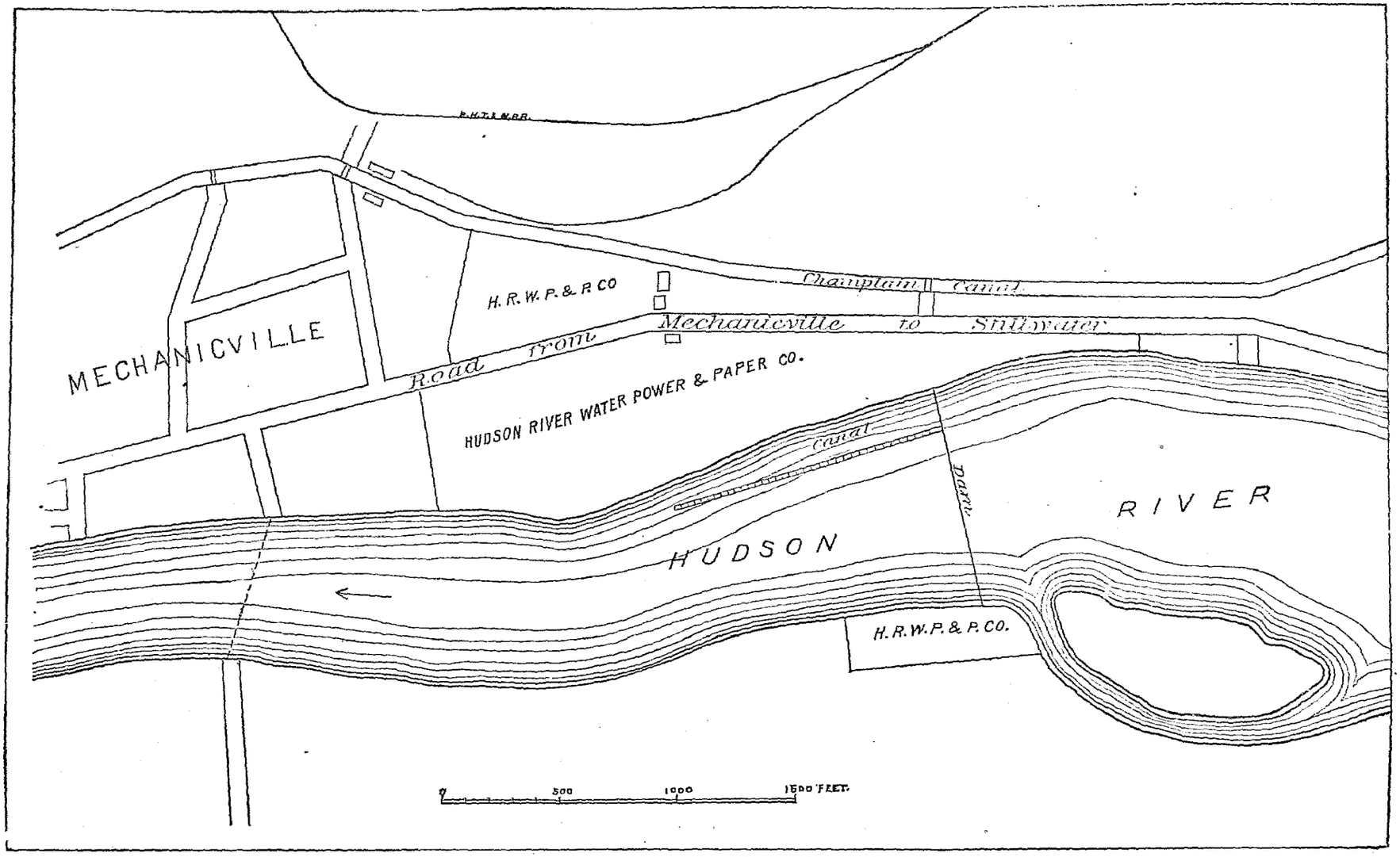

FIG. 25.—Hudson River Water-Power and Paper Company's privilege.

the average flow for the 24 hours. Without reference to storage, the theoretical power of this privilege may be placed at the figures given in the accompanying table:

Estimate of power at Mechanicsville.

Stage of river.	APPROXIMATE RAINFALL ON BASIN.					Drainage area.	Flow per second, average for the 24 hours.	THEORETICAL HORSE-POWER.		
	Spring.	Summer.	Autumn.	Winter.	Year.			1 foot fall.	16 feet (present) fall.	20 feet fall (available by raising dam 4 feet).
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*			
Low water, dry year	9	12	10½	8	39½	4,476	900	102.24	1,640	2,040
Low water, average year							1,000	113.60	1,820	2,270
Available 10 months, average year							1,600	181.76	2,910	3,640

Perhaps three-quarters of a mile above the privilege just described is what was formerly known as Howland's dam, the power at which was until recently occupied by the Saratoga Paper Company for the manufacture of straw paper. The dam is a log structure with 8 feet fall, and has a very dilapidated appearance, it having sunk in places so as to give the crest an irregular height. It runs out from the west bank to an island in mid-stream, where it abuts against a vertical rock bank. Its foundation is also rock throughout its length, but the west abutment seems to be a kind of crib-work filled in with stone and other material. Water enters to the mill by first passing through an inclosure formed by extending the abutment of the dam up stream a short distance toward the extremity of a straight embankment or dike which is carried out from the adjoining shore. At the time this power was examined the mill was not running, the property having been purchased by the Hudson River Water Power & Paper Company with the design of repairing it and engaging here, as well as at the larger privilege below, in the manufacture of paper.

Power at Stillwater.—At this locality, 3 miles or so above Mechanicsville, the river-bed is composed of slate ledges running in a direction a little east of north and dipping sharply to the eastward. The west bank is rocky and of good height, while on the east side is a rather low meadow. The Hoosac river empties opposite Stillwater, but below the dam. The latter is a log structure about 6 feet high, forming an irregular line across the river, presenting an angle up stream. It is nearly 50 years old, and though of course it has been repaired at times, the original structure still stands and serves its purpose tolerably well. A great deal of water leaks through, but there being always an abundance at the mills the loss is not felt, though roughly estimated to equal the amount used in manufacturing. The bulkhead is at the west end of the dam, and is of timber, with 13 gates, each 8½ feet wide. Each gate has two upright wooden posts with iron racks firmly attached to it, and is worked by hand-power. A short side canal, 10 or 15 feet wide, opens out from the pond 100 feet above the bulkhead and connects with the main canal, but is itself without any bulkhead. The larger canal follows down the river-bank for about a third of a mile and is 100 feet wide. It has the natural river-bank on the inshore side, and is built out into the stream, being sustained on the outer side by a masonry wall 11 feet high, 7 feet wide at the base and 5 feet wide at the top. With one important exception the mills are built out over the canal, being supported on stone piers. The wheel-pits are all built on the outside of the river-wall. One mill, as noticed, is located on the inshore side of the canal, and connects with its water-wheel by a line shaft.

Reckoned from the crest of the dam the fall at the end of the race is about 7¾ feet, and is perhaps 1 foot less near the dam. The privilege is owned by Mr. John B. Newland, of Stillwater, who estimates the power in use as follows:

1. John B. Newland, grist-mill, 60 horse-power.
2. Knitting-mill (hosiery), owned by John B. Newland, but operated by E. B. Skinner & Co., 80 hands employed, 70 horse-power used.
3. Mosher, Judd & Co., paper-mill, 15 hands, 100 horse-power.
4. D. & W. Pemble's straw-board paper-mill, 6 hands, 40 horse-power.
5. R. & H. Newland's knitting-mill (hosiery), 80 hands, 40 horse-power.
6. Denison & Co.'s knitting-mill (hosiery), 60 hands, 40 horse-power.

In all about 250 hands are employed in the mills, and, approximately, 350 horse-power of water is in use. No curtailment of power has ever been necessary because of low water. On one remarkable occasion the mills were stopped by backwater due to a heavy ice-jam, but serious trouble of this sort has been experienced only twice in a great many years. Whenever ice runs over the dam there is sufficient depth of water to carry it clear of the crest, and the structure has never suffered any injury worth mentioning from this source. Ice that forms in the pond usually rots before running out, and such as comes down from above is well broken up against the piers of a road bridge a short distance up stream, and by four crib-work ice-breakers. As we have seen, the river is subject to heavy freshets, and a depth of 5 feet on the dam is not uncommon; in an extreme case a depth of 7 feet has been

observed. During spring freshets the effective head is reduced perhaps 2 feet, but the trouble lasts not over a week; the rapids below the dam carry off the water readily and the mills are never forced to stop.

In disposing of the power, Mr. Newland sells outright the sites and rights to use certain amounts of water. The water is sold in inches, an inch being the amount passing through an opening one inch square under the head actually obtained by the mill. In practice no special measurement is made, but the amount of water used is assumed from the wheel ratings. In the deeds a reservation is made that in case of a scarcity of water the grist-mill shall first be supplied; but in view of the abundance of water it is evident that such a reservation is practically no disadvantage to the other mills. For the purpose of meeting the expense of necessary repairs on the dam and bulkhead the power is nominally divided into 25 equal parts; each privilege is estimated at a certain number of twenty-fifths, and pays a proportionate share of the expenses.

Seven mill-sites with power are still held for sale. Six of these have each a river frontage of from 75 to 100 feet with a depth of 125 feet, and one has a much larger surface. Freighting is mainly done by canal when that is open, but at other times by team to Mechanicsville. The Boston, Hoosac Tunnel, and Western railroad runs through Stillwater, but is a mile away from the mills. The Delaware and Hudson Canal Company has a line of railroad graded through the village, and in fact to Schuylerville, but the enterprise has not advanced beyond the point of grading the line.

Estimated power of the Hudson river at Stillwater.

Stage of river.	Rainfall on basin.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.			Effective horse-power utilized.
	Spring.	Summer.	Autumn.	Winter.	Year.			1 *foot fall.*	7 *feet fall.*	7½ *feet fall.*	
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*				
Low water, dry year	9	12	10½	8	39½	3,700	580	65.89	460	510	350
Low water, average year							650	73.84	520	570	
Available 10 months, average year							1,100	124.96	870	970	

Unimproved power below the Saratoga dam.—Above Stillwater the river becomes very flat, and smooth water extends from the dam a dozen miles or more, nearly to the Saratoga dam. In this distance the river valley is generally wide and rather flat, with a gradual rise to distant hills, but within 3 miles of Schuylerville the adjoining country becomes somewhat more broken. Fewer islands are to be seen than between Stillwater and Troy, and the immediate course of the river is bordered by meadows which are frequently overflowed in places. At Schuylerville bridge the river is divided by an island into two channels, one about 500 and the other 250 or 275 feet in width.

Beginning a mile or so above Schuylerville there are one or two riffles, and a third of a mile below the Saratoga dam there is an important fall. It occurs immediately above what is known as "Willis' eddy", and by pocket-level was found to be about 8 feet in 200 feet, from the head to the foot of the falls. Farther up the river-bed displays considerable bare rock at low water, but there is no more fall of consequence before reaching Thompson's mill. There is apparently a foot or two of fall in low water immediately below the mill-wheels, but it would probably disappear in a fair stage of river.

The privilege here described is owned by Mr. Lemon Thompson. The river-bed at the falls is made up of outcropping ledges of slate-rock, the greater portion exposed in low water. Opposite the main fall both banks are rocky and of good height. The east bank was examined in particular, and was found to be composed of slate-rock to a height of about 8 feet above low-water level in the pool at the head of the falls, and above that a gravelly clay for 12 or 15 feet. The power might be developed here in either of three ways. The privilege might easily be combined with that at the Saratoga dam by bringing a race down the east bank, and would give a fall at low water of at least 17 feet. If improved independently, probably not more than the 8 feet (assuming that result correctly obtained) descent at the falls could be utilized. A mill would naturally be located on the east bank on a point formed by a cove or eddy below the falls. A dam of the full height could easily be built near that place, but the better way of improving the privilege separately would probably be to build a low dam on the rocks at or near the head of the falls, and construct a canal for the remaining short distance to their foot next the east bank. A dam running only part way across the river would undoubtedly command nearly the entire low-water flow.

Estimate of power at Thompson's privilege, below the Saratoga dam.

Stage of river.	Rainfall on basin.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		
	Spring.	Summer.	Autumn.	Winter.	Year.			1 *foot fall.*	8 *feet fall.*	17 *ft. fall.*(a)
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*			
Low water, dry year	9	12	10½	8	39½	2,904	210	23.86	190	410
Low water, average year							280	31.81	250	540
Available 10 months, average year							560	63.62	510	1,080

a Assuming the privilege at the Saratoga dam to be combined with that below.

Power at the Saratoga dam.—The Champlain canal crosses the Hudson in the pool of this dam, and is also fed here for the distance thence to Waterford. The immediate valley in the vicinity is three-quarters of a mile or a mile in width, and is a well-settled, cultivated farming district. The dam is owned by the state, and the present structure was completed in 1873 or thereabout. It is in two sections, forming an angle of something over 100 degrees, with the vertex up stream; it is of stone, the face having a small batter, and rests throughout on ledge rock. The dimensions are said to be: Height, 8 feet; width at top, from 7 to 9 feet, and at base about 12 feet. The abutments are of rock-faced ashlar, and the face of the dam appears to be of the same, though it is mostly concealed from view by a sloping crib-work apron projecting some 15 feet down stream.

At the east end of the dam a short race, 50 or 60 feet wide, carries water to the saw-mill of Lemon Thompson, owner of the surplus power. This mill is located in the town of Greenwich, and about 2 miles by road above Schuylerville. The fall obtained is 9 feet; 23 wheels are run, ranging from 2 to 60 horse-power each, but many of them are of old pattern and their effective horse-power is not easily estimated. Twelve of the wheels, each 48 inches in diameter, run a Monitor "slabber" and 2 gang-saws. It was estimated that for the year 1882 the mill would have sawed about 12,000,000 feet of lumber, an amount somewhat above the average. The logs are floated down the Hudson, and this is the last mill at which they are sawed. The timber obtained is about in the proportion of spruce 4, hemlock 2, pine 1, and smaller amounts of white and yellow cedar. The mill does not run while the river is frozen, but always has sufficient water during the sawing season. For the two years previous to the fall of 1882 it was stated that water had wasted more or less every day over the dam, excepting a single day in each year. Eighteen-inch flash-boards are kept on the dam. During the lowest stage of river the pond fills at night, and there is a waste on the dam till the next afternoon, and even then the water-surface often can not be drawn down below the crest.

Power at Fort Miller.—With 18-inch flash-boards on the Saratoga dam and a fair stage of river, slack-water extends entirely to the Fort Miller privilege. There the river bed and banks are rocky and the stream is full of outcropping ledges. A log dam runs in an irregular line across the river, varying in height from 2 to 9 feet according to its position on the ledges; it is about 700 feet long, and probably 15 or 16 feet wide at the base where of full height. The state is said formerly to have had a much higher dam here, but it was abandoned and the power utilized by private parties. The farmers, however, whose land adjoined the river above and had been submerged by the slack-water from the dam, though of course they had been paid for the land thus flowed, now claimed that it should revert to them, and coming down the river in force they cut away the old dam.

On the west side of the river a low wing-dam diverts the overflow from the main structure to a small mill on the adjacent bank, not in operation. The power at the west end of the main dam is owned by Mrs. Mary C. Harris, of Northumberland, and is nearly or entirely idle. On the Fort Miller side three-eighths of the power (three-eighths of one-half the entire power of the river at this fall) is owned by the heirs of Hosea Nichols, deceased, of Fort Miller; a small saw-mill belongs to the same estate, but is not running. The remaining five-eighths of the power is owned by Wagman, Thorpe, & Co., manufacturers of hanging-papers from straw- and paper-stock. They have also a 4-run grist-mill on the privilege, operated by A. T. Pack. The fall obtained at the paper-mill is between 10 and 11 feet. The wheels have a total rated capacity of about 200 horse-power, of which from 130 to 150 is in actual use. Six 400-pound rag engines are run, and one 68-inch cylinder machine, the capacity of the mill being stated at 3 tons of finished goods per day.

The booms and piers in the river below are said to obstruct the passage of running ice, thus forming jams and causing backwater at Fort Miller. One of the most serious troubles, however, is from anchor-ice, which is thought to be aggravated by the shallowness of the pond. This form of ice is seldom observed here except in windy weather. It rises with the sun and floats, often in large masses, on the surface of the water. It freezes readily to any surface with which it comes in contact, and sometimes collects to a thickness of 1 or 2 feet on the dam and backs up the river. It hinders chiefly, though, by getting into the water-wheels and stopping them.

Estimate of power at Fort Miller.

Stage of river.	RAINFALL ON BASIN.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.			Effective horse-power utilized.
	Spring.	Summer.	Autumn.	Winter.	Year.						
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	1 *foot fall.*	10 *feet fall.*	11 *feet fall.*	
Low water, dry year	9	12	10½	8	39½	2,881	300	34.08	340	376	250±
Low water, average year							370	42.03	420	460	
Available 10 months, average year							650	73.84	740	810	

Shortly above Fort Miller the Adirondacks come plainly into view to the westward from the carriage-road through the valley, while the intervening country stretches out only slightly hilly. The banks of the river are of moderate height, and are succeeded by meadow-land. The Fort Miller dam causes slack-water for about 2 miles

up stream at low water; there is then an unimportant shoal known as "Crocker's rift", and some 2 miles farther up another even less noticeable. With a fair stage of river there would probably be continuous smooth water to Fort Edward.

Power at Fort Edward.—At this locality the river-bed is rocky, and at low water, rapids with slight descent extend half a mile or more below the dam. The latter was built by the state, probably 40 or 50 years ago, and from the pool a feeder formerly ran to the Champlain canal. On the establishment of the Glens Falls feeder the dam at Fort Edward was cut down a number of feet and abandoned by the state. It is a log structure, not filled in with stone, and presents a wretched appearance. The decay of the timber has permitted it to sink at various points, although it has been patched up, and the face has bulged out so as to present a very irregular surface. The abutments are of crib-work. This dam is about 665 feet long between abutments and 16 feet high. The mills are located on the north bank. The hydraulic canal is 1,400 feet long and averages about 40 feet in width. A separate flume 460 feet long conveys water to the Fort Edward blast-furnace. Power is further utilized here in the saw-mills of Messrs. Tefft, Hinckley, & Co. and Messrs. Bradley & Underwood, and by several other concerns of moderate size, engaged in the manufacture of paper, pottery and stoneware, flour, and machinery. In 1880 a total of about 880 horse-power of wheels, not including those of the blast-furnace, was returned as in use under a fall of about 8 feet. The estimated amount of logs sawed annually at the two mills mentioned is 30,000,000 feet, and consists of pine, hemlock, and spruce, which is cut into boards, planks, and joists, and a few shingles. Bradley & Underwood also own the power at the south end of the dam, though none is utilized there.

The Fort Edward Manufacturing Company originally purchased this privilege, and then sold the various mill-sites and rights to water to the mill-owners. The blast-furnace, Osgood & Son's machine-shop, and Durghee & Son's grist-mill have a priority of right to water in case of a short supply. For the purpose of keeping the hydraulic works in order and repair the manufacturers are associated as "The Fort Edward Dam Company". For about three months in the year there is a scarcity of water and the greater part of the works have to be shut down. There appears to be no system of management worthy the name in connection with this privilege. No measurement is made of the water used, and disputes are of frequent occurrence.

Power at Sandy Hill.—Sandy Hill is 2½ or 3 miles above Fort Edward, and is situated at the point where the Hudson suddenly changes its general course from the east to the south. There are two water-privileges, the lower known as Baker's falls and used mainly by paper-mills, while the upper is occupied by saw-mills. The country surrounding Baker's falls is comparatively level, but the river appears to have cut its way down below the general level, and descends abruptly over massive ledges of black slate-rock. This slate is described as very hard when covered by water or earth, but upon exposure to the air it soon crumbles and forms a clayey soil.

The dam runs across at the head of the falls, and thence to the pool below, a distance of only 600 or 800 feet, there is a descent of 55 feet. The river then continues for some distance in a rocky gorge, the bank rising on the left precipitately to a height of probably 75 feet. At low water there are slight rapids below the falls, but they are covered, in a fair stage of river, by slack-water from the Fort Edward dam. The dam at the head of Baker's falls is 650 or 700 feet long, and varies in height from 3 to 14 feet, according to the surface of the rock on which it is founded. It is a log structure bolted to the river-bed, and with the logs also bolted together at their intersections. Opposite the falls as well as below, the banks are precipitous and rocky. The mills are on the left bank, and receive water through a race from 600 to 700 feet long. For about 200 feet before reaching the first mill the race is 25 or 30 feet wide, and is formed between the natural rock-wall on one side and a river-wall on the other. This latter averages 14 feet in height and is 4 feet wide on top; it is provided with an overflow to the river 60 feet long, beneath which the outer surface of the wall is faced with timber. The race ranges from 14 feet in depth near the bulkhead to 11 feet at the farther extremity. Toward the end, on the outer side of a bend, there is a gate 8 feet wide extending the whole depth of the race. By opening this gate a very strong current can be obtained and the race easily flushed clear of leaves, sawdust and other refuse, and ice. In this manner an amount of work is performed in a very short time which would otherwise require days.

The bulkhead is of timber, with seven gates, each 8 feet wide. The gate-posts are of white oak, and are 8 by 18 inches in cross-section. Each gate is provided with two vertical iron racks into which the cogs upon a horizontal shaft engage; the shaft is revolved by levers, and in turn acts to raise or lower the gates. The water is used in two falls. There is but one continuous race—the upper level—and after having been used from that the water is conveyed to the lower-level wheels by each mill independently. The fall from the upper level is 31 or 32 feet, and from the lower from 22 to 24 feet. Allen Brothers' mill, the uppermost on the race, employs only the upper fall of 31 feet, but the entire fall of 55 feet will be gained by sinking the wheel-pit and tunneling thence down stream.

The users of water-power here in the fall of 1882 were Allen Brothers, manufacturers of wall-paper; Wait & Son, wall-paper; Howland & Co., manila paper; and the Sandy Hill Iron & Brass Works, manufacturers of paper-mill machinery, turbines, and various other machine work. Water is owned in square inches, nominally under 31 feet head, but practically under the full head, since each party is recognized as having a right to the full head if desired. Allen Brothers own 620 square inches of water; Wait & Son own one-eighth of one-half the flow of the river, and actually use from 250 to 300 square inches; Howland & Co., 550 square inches; and the Iron & Brass Works, 25 square inches. The total rated capacity of wheels on this privilege, October 27, 1882, was 1,847 horse-power. The supply of water is

sufficient for the works now established, even in a low stage, but there is no surplus at such times, and in the month last mentioned the entire volume of the stream was part of the time in use. The water comes down very irregularly, being affected by the control exercised over it at the mills farther up stream. Each firm owns to the center of the river, and beyond that limit Howland & Co. and J. W. Wait are proprietors to high-water mark on the opposite bank; these gentlemen also own the balance of the power on the left bank not otherwise previously accounted for.

In Revolutionary times a grist-mill was the only utilizer of the power here. The first paper-mill was started in 1844. There has been a large growth in the manufacturing interest at Sandy Hill since that time, and the place is said now to rank second in freighting importance among the stations on the Rensselaer and Saratoga railroad. The production at Wait & Son's mill is 35 tons per week, and the estimated total production of the three paper-manufacturing concerns is about 165 tons per week.

The river is considered to reach its greatest height here usually in May. For a week or so there is considerable backwater below the falls, the extreme rise there being perhaps 20 feet.

The upper privilege at Sandy Hill is improved by a log dam which runs in a broken line across the river and projects down stream somewhat. It is about 600 feet long, 9 feet high, and is very old. The foundation is solid rock, and below the dam the overflowing water has evidently torn huge slabs from the river-bed and piled them up. The abutments of the dam are crib-work loaded with stone. On the right bank power is used in Monty & Shippy's saw-mill, having a capacity for sawing about 100,000 feet of lumber in the 24 hours,(*a*) and running 25 wheels with a combined rating of about 400 horse-power. On the left bank the privilege is owned by William H. Bloomingdale, and the power is employed by Richards & Bromley in their saw-mill. Although the fall from the top of the dam is about 9 feet, yet, owing to the pond being much of the time low, the average effective head obtained is estimated as low as 7 feet. There are 18 wheels in the mill, mainly cast-iron "rose" wheels, but their power could not be learned definitely. In a busy year the mill saws about 400,000 pieces, or say 4,000,000 feet of lumber.

For about two weeks during spring, high water prevents the work of getting logs and would render it dangerous to run the mill. The ordinary freshet depth on the dam is 5 or 6 feet, but in the spring of 1869 it was only 2 or 3 inches less than 9 feet. Ice is said almost invariably to rot in the ponds on this part of the river. It seldom goes over the dams except in a kind of slush, and sometimes can hardly be perceived at all.

Power at Glens Falls and vicinity.—The two privileges at Sandy Hill succeed each other closely, but between the upper one and Glens Falls another might be developed. It is located near the foot of the gorge through which the river runs after passing the mills at the latter village, and has an available fall of 15 feet, with firm rocky bed and banks for a dam, and good building-room. It is owned, including the adjoining land on both sides of the river, by the Morgan Lumber Company, of Glens Falls, and is reckoned as good for 500 horse-power at least nine months in the year. Though not on the market, this privilege could be purchased at a suitable price. The available power may be estimated as below:

Estimate of power at the Morgan Lumber Company's undeveloped privilege below Glens Falls.

Stage of river.	RAINFALL ON BASIN.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.	
	Spring.	Summer.	Autumn.	Winter.	Year.				
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	1 *foot fall.*	15 *feet fall.*
Low water, dry year	9	12	10½	8	39½	2,716	160	18.18	270
Low water, average year							240	27.26	410
Available 10 months, average year							520	59.07	890

At Glens Falls we encounter the second great pitch in the river, amounting to about 40 feet from the top of the dam to the foot of the main falls. The Hudson here runs easterly, while the rock strata have a southerly dip of about 20 degrees. Down through these strata the stream has worn its way, forming below the falls a natural gorge with steep sides, though its form has been destroyed by extensive quarrying next the river. The gorge continues for from a third to a half-mile down stream, after which the banks become more gentle in slope. The feeder to the Champlain canal runs at no great distance from the river, on the north side, and the sheets of water which fall down into the river at various points from between the rock strata indicate a considerable leakage. Below the falls, at least, the original continuity of the strata on the opposite sides of the river is easily apparent. A vertical section shows the following materials: from 14 to 15 feet of sand, gravel, and other surface deposits, then 12 feet of inferior limestone, 14 feet of a nondescript stone called "buckwheat", 2 or 3 feet of gray marble, 12 feet of black marble, succeeded by lime-rock and building-stone. The black marble takes a fine polish, and on the north side of the river, Finch, Pruyn, & Co. have an establishment for working it. Limestone is quarried and burned on both banks, the Morgan Lime Company owning the works on the south side.

a Saw-mills in this section run night and day during the working season.

The lumber interests at Glens Falls are very extensive. Logs are cut from 20 to 100 miles northward on the upper waters of the Hudson and its tributaries and floated down. The Morgan Lumber Company has sawed as high as 35,000,000 feet of lumber in a single year. In 1881 the amount, including refuse, was 27,000,000, and for 1882 had reached about 21,000,000 feet on October 27. The logs are spruce, hemlock, and pine, in the order named as regards quantity. In busy times about 150 men are employed at this company's mills.

The dam is at the head of the falls, and is a timber crib-work built on solid rock. The intersections of the timbers are firmly bolted, and the whole structure is secured in a like manner to the foundation rock. The timbers are squared and so laid as to form a tight face and back, the top of the dam being also closed by planking. The dam is in three sections, two running diagonally, somewhat up stream, and the third closing the gap between them. The whole length is about 400 feet, while the height varies from 5½ to 6½ feet. Near the center is a sluice-way, 45 feet long, for logs; it is shod with iron straps, and is depressed below the main crest of the dam 24 inches for 10 feet of its length and 10 inches for the remaining 35 feet. The face and back of the dam are vertical, the back being from 2 to 2½ feet high; the top of the structure has a slope up stream, and is from 10 to 11 feet wide. The abutments and bulkheads are formed by timber and stone crib-work piers. There are no gates, properly so called, controlling the admission of water to the races, but each main race is divided by timber partition-walls into minor races so as to keep the logs separate for the different saws. On the north side of the river there are three of these divisions and on the south side five; still another race on the latter side is supplied with water by the overflow from the main dam, which is diverted to the race by a second low dam—a wing about 2 feet high running from the center of the stream to the south bank.

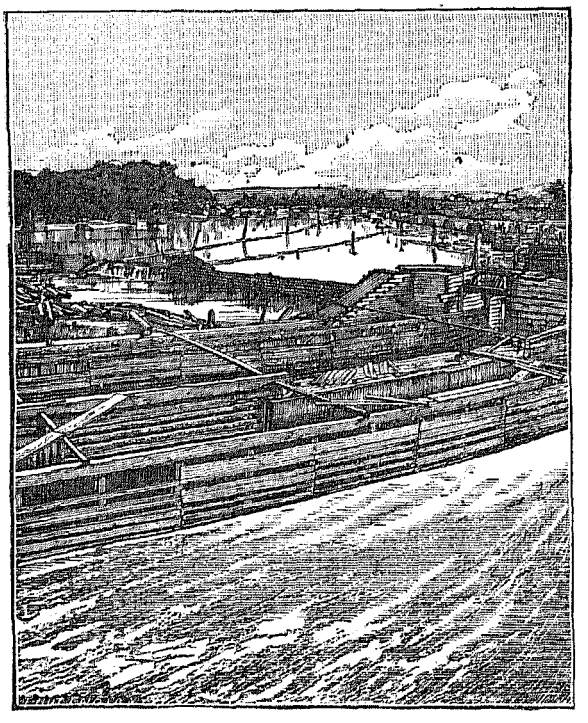

FIG. 3.—View of Hudson river at Glens Falls dam, showing booms and piers for holding logs.

The power on the south bank is owned in part by three different concerns, and is used in three separate and successive falls. The Morgan Lumber Company is the principal user. Its mills are shortly below the dam, and at them the water is first employed under a head of 15 feet, the tail-water then passing in a common race to its lower mill and to Lapham & Co.'s grist-mill. The latter firm has a right to sufficient water for 9 runs of stone; it uses about 9 feet head and operates 7 runs of stone, with water-wheels having a total rated capacity of from 200 to 250 horse-power. Tail-water from the grist-mill is discharged directly into the river. The Morgan Lumber Company's lower mill uses its share of water from this second level under 16 feet head. Of its tail-water, which forms a third level, part runs through a long open wooden flume down to the lime company's works, but the chief portion furnishes power for the Glens Falls Paper Mill Company, manufacturing printing-papers, with a production of 5 tons per day. The water is here used under a head of 11 or 12 feet and discharged into the river. The company owns water sufficient for 4 Fourdrinier machines, but prior to it the grist-mill is entitled to its supply, and the Morgan company to water for 4 gates.

On the north side of the river the power is all owned and the works are operated by Messrs. Finch, Pruyn, & Co. This firm has here a large saw-mill, a planing-mill, a grist-mill, marble works, and lime and marble quarries. At all of these except the quarries water-power is used, the aggregate amount being stated at 825 horse-power. At present the power on this side of the river is not thoroughly developed, some of the water being returned to the river before it has been utilized through the entire fall. The saw-mill, a short distance below the dam, uses water first under a head of 12 or 14 feet, and discharges directly into the river. A separate flume leads to the 3-run grist-mill, which has about 14 feet fall. Its tail-water is conveyed through another flume to the marble works, where it is used and discharged into the river.

For two or three months in the year the supply of water is insufficient for the needs of manufacturing at Glens Falls, although the mills can run more or less even during that time. The aggregate of power in use on both sides of the river can not be stated with any accuracy, but probably amounts to from 2,000 to 2,100 horse-power.

The next power to be noticed is about 1 mile above the main village of Glens Falls, at the state feeder-dam. There are some riffles before reaching it, but the fall is said to be too slight to have any importance. The dam is straight, 618 feet long between abutments, and is a crib-work filled with stone, with a sloping apron of the same construction, the whole planked over; it rests on rock, and was built about 1875. A sluice-way in the center provides for running over logs. The abutments are rock-faced masonry. At the north end of the dam is a double lock, one side for boats and the other to serve as a water-way only. The Glens Falls feeder runs from this point to the Champlain canal and carries off a large amount of water, there being a rapid current through the lock. The

surplus power at this end of the dam is owned by Van Deusen & Freeman, and is used by them in a saw-mill running 25 or 30 water-wheels, power unknown, and sawing an average of from 10,000,000 to 11,000,000 feet of lumber per year. The mill is close to the dam and has a fall of 14 or 14½ feet. On the south side the power is owned and used in large saw-mills by Finch, Pruyn, & Co. and A. Sherman. The state maintains 20-inch brackets on the dam, and will not permit the mills to draw down the pond more than half-way on these brackets. There is more or less shortage of water at the mills during four months in the year.

Glens Falls to Palmer falls.—Above the feeder-dam slack-water continues for some 6 miles, the greater part of which is included in a long bend, or "ox-bow", and here is the great "Hudson River boom", where immense numbers of logs are held for the use of the mills on the river below. The surrounding country is level and sandy as far as the mountains, several miles west of Glens Falls.

Immediately succeeding the slack-water formed by the feeder-dam, Messrs. Van Deusen and Sherman own an unimproved privilege which they hold for sale. It is about 4 miles from the railroad, offers a pebbly bed for a dam and has a large tract of level land adjacent. The privilege is reckoned at from 20 to 30 feet fall according to the height of dam. With a dam 6 feet high and a race three-quarters of a mile long it is stated that a fall of 22 feet can be obtained. The corresponding power may be estimated as below:

Estimate of power at Van Deusen and Sherman's unimproved privilege above the "Hudson River boom".

Stage of river.	RAINFALL ON BASIN.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.			
	Spring.	Summer.	Autumn.	Winter.	Year.						
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	1 *foot fall.*	20 *feet fall.*	22 *feet fall.*	30 *feet fall.*
Low water, dry year	9	12	10½	8	39½	2,704	260	29.54	590	650	890
Low water, average year							340	38.62	770	850	1,160
Available 10 months, average year							620	70.43	1,410	1,550	2,110

Upon following the course of the river into the mountains there is found to be a continuous rapid for some miles; this is succeeded by quiet water for half a mile or so, after which there are rapids at short intervals. Through the mountains, before reaching Palmer falls, so far as there was opportunity to examine, the bed was found to be composed of gravel and bowlders, without displaying much ledge rock. The banks are rocky in places, but to a large extent are of sand with bowlders intermixed. The valley is comparatively narrow, and is inclosed by high hills which frequently rise abruptly from the stream, especially on the right. The valley is sparsely settled, without any, railroad, has apparently small value for farming, and is not suited to the location of large villages.

Power at Palmer falls.—The privilege at that place is owned by the Palmer Falls Water Power Company (not incorporated), J. S. Alexander being the local representative of the company's interests. The power is but partially developed, and apparently no special effort has been made for its thorough improvement. It is a magnificent privilege, but appears difficult and expensive to utilize completely. Past Hadley, at the mouth of the Sacondaga, the Hudson runs southerly, and soon enters a more open country than it has previously traversed. A few miles below Hadley it turns and runs easterly. From Rockwell falls, just above the Sacondaga, down to Jessup's landing there is said to be smooth water, which was observed to be the case wherever the river was visible from the carriage-road. Shortly below the ferry at Jessup's landing rapids begin, and the stream enters a rocky gorge in the hills. In a distance which was judged to be less than a mile there was stated to be a descent of from 105 to 110 feet, and 80 feet of this is concentrated within a few hundred feet at Palmer falls.(*a*) The scenery at that point is rugged and grand; the river is confined between precipitous ledges, its bed is solid rock, and its waters pass down in a final plunge of nearly 30 feet into a pool below. Quiet water then succeeds for perhaps half a mile down stream, after which the character of the river is as has already been described.

The steep rocky sides between which the river flows above the principal falls render its improvement there impracticable. The last 80 feet, including those falls, has been partially improved, however, though only 30 feet is actually utilized. At the head of the main falls a log dam extends across the river in an irregular line, following some distance parallel to the right bank so as to give sufficient overflow. It is a crib-work structure with vertical face, and on top a short slope each way from the crest. The roll-way is 600 feet long, with a height ranging from 10 to over 30 feet, but averaging about 25 feet. It abuts against the rocky wall of the stream on the left, and on the right has a masonry abutment. Water is admitted to the race through a timber bulkhead measuring from 40 to 50 feet across and having 4 gates. From the bulkhead this race is continued some 300 feet, being confined on the river side by a masonry wall averaging 25 feet in height and 4½ or 5 feet in width on top, while on the shore side is the natural wall of rock. This race constitutes the upper level, which has been improved by the Hudson River Pulp & Paper Company with the view of locating new mills between it and the lower level, to be described. A dispute between this company and the water-power company, however, has brought operations

a The total fall from Jessup's landing to the top of the feeder-dam was reported to be 200 feet, but the accuracy of the statement can not be vouched for. The fall is probably at least the amount reported.

to a stand-still, after an expenditure by the former of about $35,000 for dam, race, and connected work. The level now terminates in a timber bulkhead and on one side a weir 80 feet long, over which water falls to the lower level.

Any overflow from the dam and any leakage through it are at low water diverted entirely to the lower level by a natural barrier of rock which extends across the course of the stream a short distance below the dam. The water enters this level through a timber bulkhead and passes on to the mills, being sustained on the river side by a wall of crib-work. The fall from the upper level to the lower is about 50 feet, and thence to the river 30 feet. The only use of power here is made by the company already mentioned, manufacturer of news- and hanging-papers and refined spruce and poplar wood-pulp. The production is 10 tons of paper and 8 tons, dry weight, of wood-pulp per day. All the pulp is worked up here in the manufacture of paper. Water for power is taken entirely from the second level, and used under a head ranging from 20 to 30 feet on the different wheels, but estimated as averaging about 27 feet. The total horse-power of wheels in place is from 1,450 to 1,500.

There has been manufacturing of some kind at this privilege for forty or fifty years, and power was formerly used by a small woolen-mill. The paper-mill has been located here since about 1870. With the present head in use it at times requires all the flow of the river. This was the case in the summer of 1882, and even toward the end of October in that year.

Estimate of power at Palmer falls.

Stage of river.	RAINFALL ON BASIN.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.				Effective horse-power utilized.
	Spring.	Summer.	Autumn.	Winter.	Year.			1 *foot fall.*	30 *feet fall.*	50 *feet fall.*	80 *feet fall.*	
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*					
Low water, dry year	9	12	11	8	40	2,650	250	28.40	850	1,420	2,270	1,450–1,500
Low water, average year							330	37.49	1,120	1,870	3,000	
Available 10 months, average year							600	68.16	2,040	3,410	5,450	

The Hudson at Hadley and above.—There is quiet water, as has been said, from Jessup's landing to Hadley. At the latter point, immediately above the mouth of the Sacondaga river, is the last improved power, so far as was learned, on the river. It is at the foot of what were known as Rockwell falls, and is occupied by the Rockwell Falls Fiber Company, manufacturer, by chemical process, of wood-pulp from pine, spruce, bass, and poplar, with a production of 5 tons per day. The dam is a log and stone crib-work about 140 feet long and 13 feet high, with a sloping apron; including the apron, the width of the structure at the base is 40 feet. It was built in 1881 and cost $5,000. Wheels of an aggregate of 120 horse-power are in use under 13 feet fall, and there is always much more than enough water for running them. The mill is on the Hadley side, and just across the stream is the village of Luzerne.

Slack-water from the dam just described extends but a short distance, and then there are short falls with rocky bed and banks. Thence 14 miles to Thurman there is smooth water nearly all the way, with very few riffles even. The bed is gravelly, while the immediate banks are in the main sandy, and in places successive terraces are seen rising from the stream. As we ascend above Hadley the immediate banks become lower, and the river is frequently divided by islands. The valley contracts, and is hemmed in by high rocky hills, so denuded of timber as to present a bare and forbidding appearance. It is seldom more than a quarter or a third of a mile wide between the bases of the hills, and frequently the distance diminishes to a few hundred feet. There are but few habitations, and the land in the valley appears practically valueless for farming.

Above Thurman the fall is more rapid. There are riffles at short intervals, and at length the rate of descent becomes uniformly swift. The bed and banks also change their character; the former is now covered with bowlders, and even displays ledges at intervals, while the banks are also rocky much of the way. At North Creek bridge the Hudson is 250 feet wide, with a firm gravelly bed and a good current. It is there subject to sudden and heavy freshets, and at such times overflows the adjoining flats, though they do not reach far back from its course. The surrounding hills were once heavily clothed with timber, but now display for the most part naked masses of rock. At present the cutting of timber is mainly 30 miles or more to the northward from North Creek. The Adirondack Company's railroad has not been extended above that village, and the examination of the river ceased there. The stream was described as retaining, for a long way above, the same general features that have already been noticed as characterizing its course north from Thurman.

Summary of water-privileges on the Hudson river.

Locality.	Manufacture.	Drainage area.	Fall.	Estimated theoretical horse-power. (a)			Effective horse-power of wheels in use.	Remarks.
				Low water, dry year.	Low water, average year.	Available 10 months, average year.		
		Sq. miles.	*Feet.*					
From lake Tear-of-the-Clouds to the mouth of North creek.			3,341					Fall entirely unimproved. River not accessible by railroad.
Below the mouth of North creek.		753		*b* 7.95	*b* 11.36	*b* 19.31		River about 250 feet wide, with good current and gravelly bed.
From North creek to the crest of the Rockwell Falls dam.			431					River followed by railroad. Narrow rocky valley and very little settlement. No use of power.
Hadley (Rockwell falls)	Chemical wood-pulp	1,598	13	240	300	590	120	Production 5 tons per day.
Palmer falls	News- and hanging-papers and wood-pulp.	2,650	80	2,270	3,000	5,450	1,450–1,500	Manufacturing carried on by the Hudson River Pulp & Paper Company. Privilege owned by the Palmer Falls Water Power Company. Only 30 feet fall actually in use.
Four miles west of Glens Falls.	Unimproved	2,704	20–30	590–890	770–1,160	1,410–2,110		Privilege owned by Van Deusen and Sherman. It is stated that a dam 6 feet high and a race three-quarters of a mile long will give 22 feet fall. Pebbly bed for dam, and abundant building-room.
State feeder-dam	Lumber		14				(*c*)	Dam owned by the state. Surplus power used by large saw-mills on both sides of the river.
Glens Falls	Lumber, paper, flour, marble, and lime.	2,716	40–43				2,000–2,100	Scarcity of water during two or three months in the year.
Do	Unimproved		15	270	410	890		Privilege owned by the Morgan Lumber Company. Rocky bed and banks, and good building-site.
Sandy Hill (upper privilege).	Lumber	2,724	7–9				900(?)	
Sandy Hill (Baker's falls)	Wall-paper, manila paper, and machinery.		55				1,847	Estimated production of paper, 165 tons per week. Full power of the privilege not yet developed.
Fort Edward	Lumber, iron, pottery, stoneware, paper, and flour.	2,744	(*d*)				880±	Two mills saw annually about 30,000,000 feet of lumber.
Total from the mouth of the Sacondaga river to Fort Edward.			418					From 200 to 220 feet may be regarded as developed for use, though not all of this amount is actually employed.
Fort Miller	Hanging-paper, mainly	2,881	11	370	460	810	250±	Small power also used by a grist-mill.
Saratoga dam	Lumber	2,904	9				160(?)	State feeder-dam, and pool also used for crossing of Champlain canal. Surplus power owned by Lemon Thompson. About 12,000,000 feet of lumber estimated to be sawed at mill in 1882.
Short distance below the Saratoga dam.	Unimproved		Say 8	190	250	510		Owned by Lemon Thompson. Favorable for improvement.
Stillwater	Hosiery, paper, and flour.	3,700	7¾	510	570	970	350	Power owned by John B. Newland. Several good sites with power yet for sale.
Mechanicsville (Howland's dam).	Manufacture will be paper.		8					Now owned by Hudson River Water Power & Paper Company.
Mechanicsville (main privilege).	Manufacture will be paper and wood-pulp.	4,476	16	1,640	1,820	2,910		Newly developed. See description. Twenty feet fall available by raising dam.
From Mechanicsville to Troy.	Unimproved		*e* 30±	*b* 102.24	*b* 113.60	*b* 181.76		It is estimated that one good privilege with 18 feet fall can be established.
Troy and Green Island	Paper, sashes and blinds, flour, and stoves.	8,034	10				1,203+	Power on east side represented by Troy Hydraulic Company. On west side leased by heirs of G. M. Tibbits. State owns dam, and only surplus water can be used.

a Based upon average flow for the 24 hours. *b* Per foot fall. *c* Amount uncertain.
d Dam 16 feet high, but head actually in use stated to average only about 8 feet. *e* Total fall.

TRIBUTARIES OF THE HUDSON RIVER.

In view of the large number of tributary streams included within the Hudson River basin and having more or less value for power, it was impracticable to attempt more than to gain a reasonably full description of some of the more important of them, and personal examinations were confined to the larger streams emptying above Troy. A great many streams were thus omitted which are suited to powers of moderate size, and which would in some instances doubtless support very considerable manufacturing interests. The aggregate of power in use on these is also large, but mainly distributed among small mills, and sufficient knowledge upon that point can probably be gained from the tables of utilized powers.

List of the principal tributaries of the Hudson river.

Name of stream.	Drainage area.	Name of stream.	Drainage area.
	Sq. miles.		*Sq. miles.*
Indian river	124	Catskill creek	419
Schroon river	556	Jansen's kill	239
Sacondaga river	1,028	Esopus creek	438
Batten kill	457	Rondout creek	1,252
Fish creek	253	Wappinger creek	183
Hoosac river	710	Fishkill creek	189
Mohawk river	3,493	Murderer's creek	165
Norman's kill	161	Croton river	368
Kinderhook creek	534		

THE MOHAWK RIVER.

This important river has its sources in western New York state, near the boundary between Lewis and Oneida counties, about 40 miles from the eastern end of lake Ontario and 15 or 20 miles north of the city of Rome. It runs southerly to that city, and then takes a course somewhat south of east across the state, passing through the counties of Oneida, Herkimer, Montgomery, Schenectady, and forming the boundary between those of Albany and Saratoga, finally emptying into the Hudson a little above Troy. It has a drainage area of 3,493 square miles, a length by actual course of from 140 to 145 miles, and receives successively below its source, as principal tributaries, Oriskany, West Canada, East Canada, and Schoharie creeks, the first and last of these from the south, while the Canada creeks come from the Adirondack mountains to the northward. From Rome to its mouth the Mokawk is closely followed by the Erie canal and the New York Central and Hudson River railroad. The valley has thus become a great thoroughfare between the West and the East, and in it a line of prosperous towns has sprung up, the most important places, in order from the head, being Rome, with 12,000 inhabitants; Whitesborough, 1,400; Utica, 34,000; Frankfort, 1,100; Ilion, 3,700; Mohawk, 1,400; Herkimer, 2,400; Little Falls, 6,900; Saint Johnsville, 1,100; Fort Plain, 2,400; Canajoharie, 2,000; Fultonville, 900; Fonda, 900; Amsterdam, 9,500; Port Jackson, 700; Schenectady, 13,700; Cohoes, 19,400; and Waterford, 1,800.

The immediate valley of the Mohawk is broad and open, frequently 1 or 2 miles in width, and is made up of level meadows from which there is a rise, usually gradual but sometimes abrupt, to the summits of high hills which attain altitudes of several hundred feet above the stream. The valley is not, however, throughout as open as has been described; toward the mouth it becomes at points quite contracted and the meadows disappear; at other localities rocky bluffs now and then approach the stream on one side or the other, and at Little Falls it cuts through a remarkable gorge, the rocky walls of which rise precipitously 500 or 600 feet. West of Rome the water-shed between the river basin we are considering and the section draining toward lake Ontario has an elevation above sea-level of only about 430 feet. This is said to constitute the lowest pass in the Appalachian system of mountains, and has been taken advantage of as a route for the Erie canal.

The highlands to the north of the river valley are succeeded by an elevated plateau having a general slope toward the river, and rising here and there in summits to elevations of from 2,500 to 3,000 feet above tide. Transparent lake, drained by the upper waters of West Canada creek, has an altitude of 2,187 feet above sea-level. The flats which border the river have a rich alluvial soil finely suited to the raising of grass, grains, and broom-corn; the more elevated lands are covered with a sandy and gravelly loam of fine quality, and there stock-raising and dairying are the principal industries. To the northward, where the Mohawk basin touches upon the Adirondacks, the primary formation is met with, and granite, gneiss, hornblende, and allied rocks prevail. These occasionally crop out also at localities farther south, as at "the Noses", bordering the river in Montgomery county, and at Little Falls. At Cohoes and other points along the lower river the bed and banks are composed of Hudson River shale and slate. In Montgomery county heavy masses of calciferous sandstone appear on the north side of the stream, and the Black River and Trenton limestones afford valuable quarries of building-stone. In Herkimer county the Utica slate is said to crop out on the summits of all the hills immediately north of the Mohawk.

Below Rome the fall in the river is in general small and quite uniform, being made up of long quiet reaches separated by slight riffles. At Little Falls the uniformity is broken and the river descends in successive falls a total of about 45 feet in 2,500. From Rome to the lower aqueduct, at Crescent, a distance of 110.7 miles, there is a fall of 269 feet, or an average of 2.43 feet per mile. Thence to the level of slack-water above the Troy dam there is a farther descent of 149.5 feet in 4.4 miles, but of this 104 feet is included within the magnificent improved power at Cohoes.

Table showing the fall in the Mohawk river.

Locality.	Distance from mouth of river.	Elevation of water-surface above mean sea-level.	Distance between points.	Fall between points.	Fall per mile between points.	Authority for elevation.
	Miles.	*Feet.*	*Miles.*	*Feet.*	*Feet.*	
Rome above feeder-dam	115.1	430.5				
			3.0	12.1	4.03	Erie Canal profile.(*a*)
New York Central and Hudson River Railroad crossing 4 miles east of Rome.	112.1	418.4				
			17.0	25.1	1.48	New York Central and Hudson River Railroad profile.(*b*)
New York Central and Hudson River Railroad crossing 3 miles east of Utica.	95.1	393.3				
			53.5	123.3	2.30	Do.
Mouth of Schoharie creek	41.6	c 270.0				
			22.4	56.3	2.51	Do.
New York Central and Hudson River Railroad crossing at Schenectady.	19.2	213.7				
			14.8	52.2	3.53	Do.
Lower aqueduct	4.4	c 161.5				
			4.4	149.5	(*d*)	The Erie Canal profile gives water-surface in canal at aqueduct as 187.99 feet + mean low-tide at Albany.
Mouth of river	0.0	c 12.0				Estimated elevation of slack water above Troy dam at mouth of "North branch".

a The plane of reference for that profile is mean low-tide at Albany, which is 2.07 feet above mean sea-level.
b A large number of elevations on the lines of this railroad were kindly supplied by Mr. Charles H. Fisher, chief engineer.
c Approximate.
d Fall mainly concentrated at Cohoes.

For a large part of the year the Mohawk is comparatively steady in flow, but at times it becomes swollen to a violent flood, and in spring bears along heavy masses of running ice. In one freshet 20 years ago there is said to have been a depth of 12 feet of water on the Cohoes dam. When it is considered that this was upon a roll-way some 1,400 feet long, an idea is gained of the tremendous volume of water that must then have been pouring down the course of the stream. At the lower and upper aqueducts spring-freshet rises of 9 or 10 feet are not uncommon, and on the rifts at the former point the river is said to have risen many years ago to a level with the canal, or about 28½ feet. Such excessive rises seem to have been aggravated by ice-gorges, which even now often form below Schenectady, in the vicinity of Little Falls, and very likely at other localities, but which are less dangerous than formerly, as there are more obstructions in the form of piers and dams to break up the ice. The general clearing up of the country, the more extended cultivation of the soil, and the drainage of swamp-lands in the vicinity of Rome, have combined to produce, in general, greater fluctuations of flow than formerly characterized this river. Twelve hours after a rainfall in the center of the state its effect is usually visible at Cohoes.

At a number of points the Mohawk is drawn upon, either directly by dams across its course and connecting feeders, or indirectly by tapping its tributaries, to supply the Erie canal during the season of navigation. The draughts thus made vary somewhat from time to time, according to the amount of traffic passing over the canal and from other causes, but on the whole are tolerably uniform, and at several localities are quite large. How much of the water ultimately finds its way back into the river through one channel and another it is of course impossible to say. The extent of the demands made upon the Mohawk for canal purposes may be learned from the following statement, the data for which are taken from the *Annual Report of the State Engineer and Surveyor* for the year 1867:

Diversion of water to the Erie canal.

Source of supply.	Amount furnished per second.	Remarks.
	Cubic feet.	
Champlain canal and Mohawk river at Cohoes	110	Includes the amount coming down the Champlain canal, the balance being taken from the Mohawk.
Mohawk river at Rexford Flats	183	
Schoharie creek	113	Taken from the creek near its mouth and conveyed through a short feeder
Mohawk river at Rocky rift	177	4½ miles below Little Falls.
Mohawk river at Little Falls	211	Taken from the pool above the upper dam.
Ilion creek	13	
Oriskany creek		Dam near mouth, with short feeder. At Solsville, near the head of the creek, a diversion is made to the latter of a considerable amount of water from a series of reservoirs lying naturally within the basin of the Chenango river. A portion of their supply passes down to Utica via the Chenango canal, the receipt from which source is stated at 15 cubic feet per second; the remainder descends through Oriskany creek and is controlled by the dam above mentioned.
Butt's creek	23	2½ miles east of Rome.
Upper Mohawk river, and reservoirs in the Black River basin; supply received at Rome.	218	In the upper basin of Black river is a series of large reservoirs, the storage of which is conducted to Boonville, on the summit level of the Black River canal. One portion passes down that canal northward toward Carthage. A second portion descends southerly through the Black River canal to Rome, being re-enforced, 4 miles north of the city, from the Mohawk river, by means of the "Delta" feeder; the receipts of the Erie canal at Rome from this source are stated at 22 cubic feet per second. The third and remaining portion of the water descends through the channel of the Lansing kill and upper Mohawk to Rome, increased on the way by the natural drainage to the river, and is there controlled by a dam and feeder, supplying thus 196 cubic feet per second to the Erie canal.

WATER-POWERS.—Shortly before reaching the Hudson river the Mohawk divides into three principal channels, separated by islands, and by throwing dams across the minor passages which are formed by other and smaller

islands in the northern of the main channels, two very good water-privileges have been developed. The lower of these privileges is along what is known as "King's ditch", or "King's canal". A short timber dam runs out on the rocky bed of the river to a small island, and beyond it is continued in a second section to the large Haver island which divides the north and middle channels of the river. Water is admitted to the canal through a timber bulkhead about 45 feet long, and passes half a mile down the north bank of the river, supplying on its way the various mills which are between the canal and river. The fall obtained is 13 or 14 feet.

This privilege was developed some 50 years ago by Foster King, and rights have been sold off at various times since to the mill-owners. The whole power is nominally divided into twenty equal parts. Repairs are attended to by an association of the manufacturers called the King's Canal Company, and each share is assessed for its proportion of the resulting expenses. No system of measurement is maintained, however, to insure that each mill shall receive the proper amount of water. For about nine months in the year there is an abundant supply, but the remainder of the time there is more or less scarcity, usually in summer, but sometimes also in winter. The manufacturing at this privilege comprises stove-nuts, printing paper, stocks and dies, straw-board, flour, and machine work. There are seven different mills and shops, and in 1880 an aggregate of nearly 450 horse-power of wheels was in use.

The next power, a short distance above, is owned by Messrs. Himes & Vail, who run 10 sets of machinery in the manufacture of shirts and drawers. The privilege is a very old one, and was formerly occupied by a grist-mill and a satinet-mill. The extreme northerly channel of the Mohawk is here crossed by a timber dam resting on a ledge and running out to the high rocky bank of Mill island. It presents an angle up stream, has a vertical face, and is to be replaced by a new framed structure. Water is admitted through a wooden bulkhead and carried several hundred feet to the mill in an open wooden flume and a cylindrical wooden trunk, the latter of 3-inch pine, 5½ feet inside diameter. The dam has a mean height of 6¾ feet, and rapids which extend below increase the head at the mills to 12 feet. One wheel of 50 and one of 80 horse-power are employed. Himes & Vail not only have enough water for their own use, but estimate a permanent surplus of 150 horse-power, which they would like to lease for manufacturing purposes. They state that for a desirable party they will erect a suitable building, leasing the room and power.

A short distance above the power just described is the third from the Hudson, formed by the state dam in the pool of which the Champlain canal crosses. The dam is a fine structure of stone, represented on a local map as 1,500 feet long; it has masonry abutments and a sloping apron of crib-work. Before this dam was built for canal purposes there were wing-dams here at which power was used, and the present privileges were received from the state in exchange for for rights surrendered. At the south end of the dam are the works of the Weed & Becker Ax Manufacturing Company, and at the north end, a little way along on the line of the canal, is the Munson Manufacturing Company's mill. This concern makes knit underwear, running 7 sets of machinery. It obtains 10 feet fall, and uses not over 90 horse-power from 3 water-wheels rated in the aggregate at 125 horse-power.

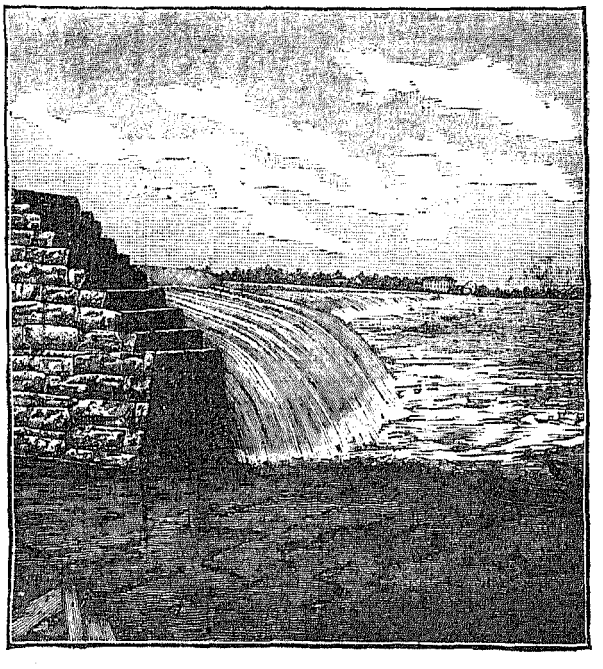

FIG. 5.—View of Cohoes Company's dam.

Power at Cohoes.—The Mohawk at this point runs in a rocky trough, the bottom and sides of which are composed of Hudson River slate and shale; the strata have a dip to the northwest, and in an artesian-well boring are said to have been found to a depth of 2,300 feet. The rock contains many pot-holes, some of great size. In preparing the foundations for one of the Harmony mills a very large pot-hole was encountered containing the bones of a mastodon, from which circumstance the mill came to be known as the Mastodon mill. The skeleton of the gigantic animal is now at the museum in Albany. The river falls rapidly past the city, descending, as nearly as can be ascertained, about 139 feet from the top of the Cohoes Company's dam to the level of slack-water from the Troy dam. Included in this are the "falls" proper, where the river suddenly pitches down a steep face of rock. In low water the volume of the stream passes around these falls, through the hydraulic canals, and there is only to be seen the dark and massive ledge, relieved by one or two silvery streaks where a little escaping water finds its way down.

Water is taken from the river about 3,700 feet above the great falls and nearly 9,000 feet above the state dam previously referred to. The first dam, a wooden structure, was erected in 1831, partially destroyed by ice in 1839, and repaired in the same year. A new dam, of wood, was also built in that year, about 50 feet below the first one, and served until 1865, when the present dam was built, immediately below and adjoining that of 1839, the two forming substantially one structure. The roll-way of this dam is 1,400 feet long, while the height averages about

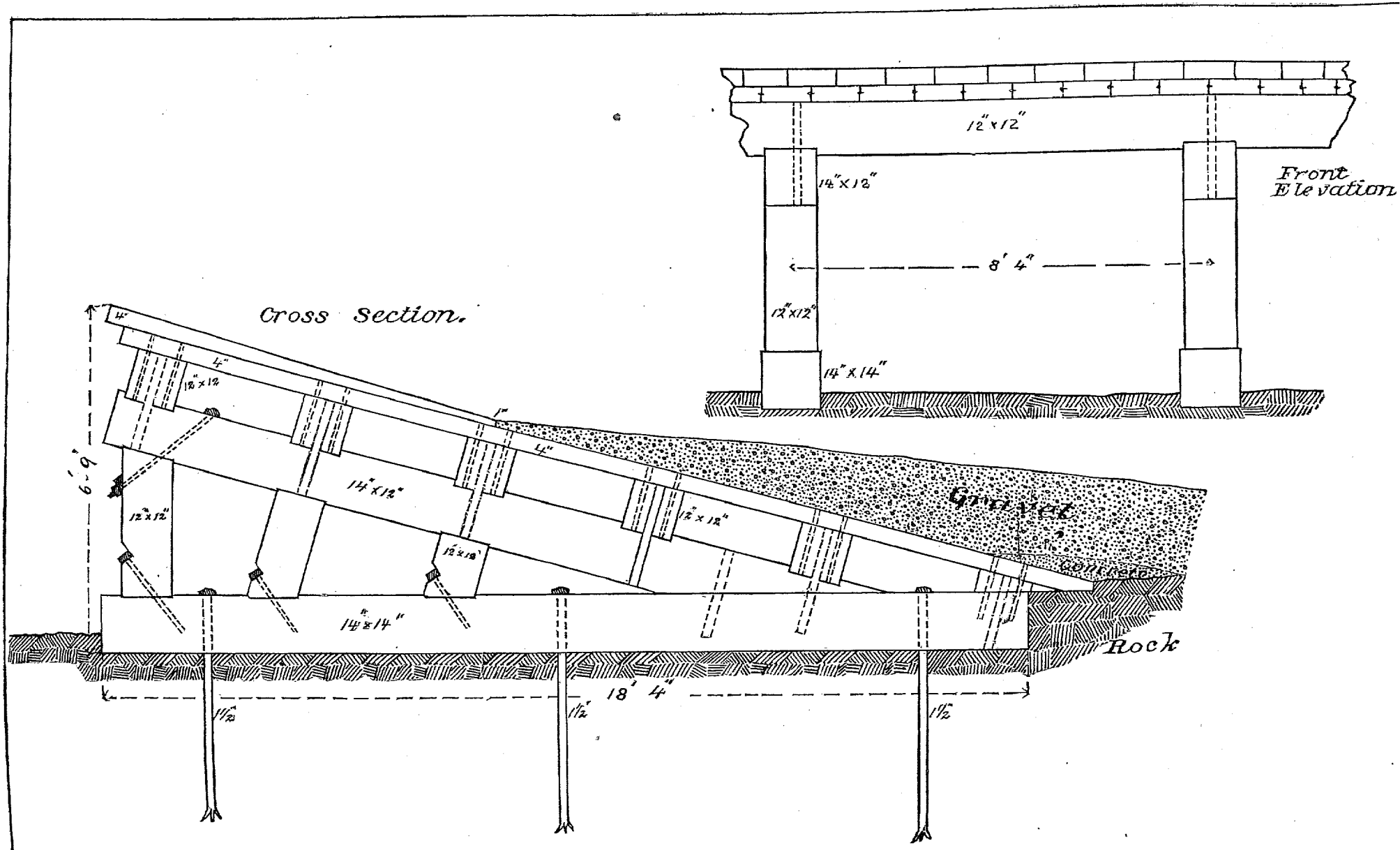

FIG. 4.—Deisgn for new dam for Messrs. Himes and Vail at Waterford.

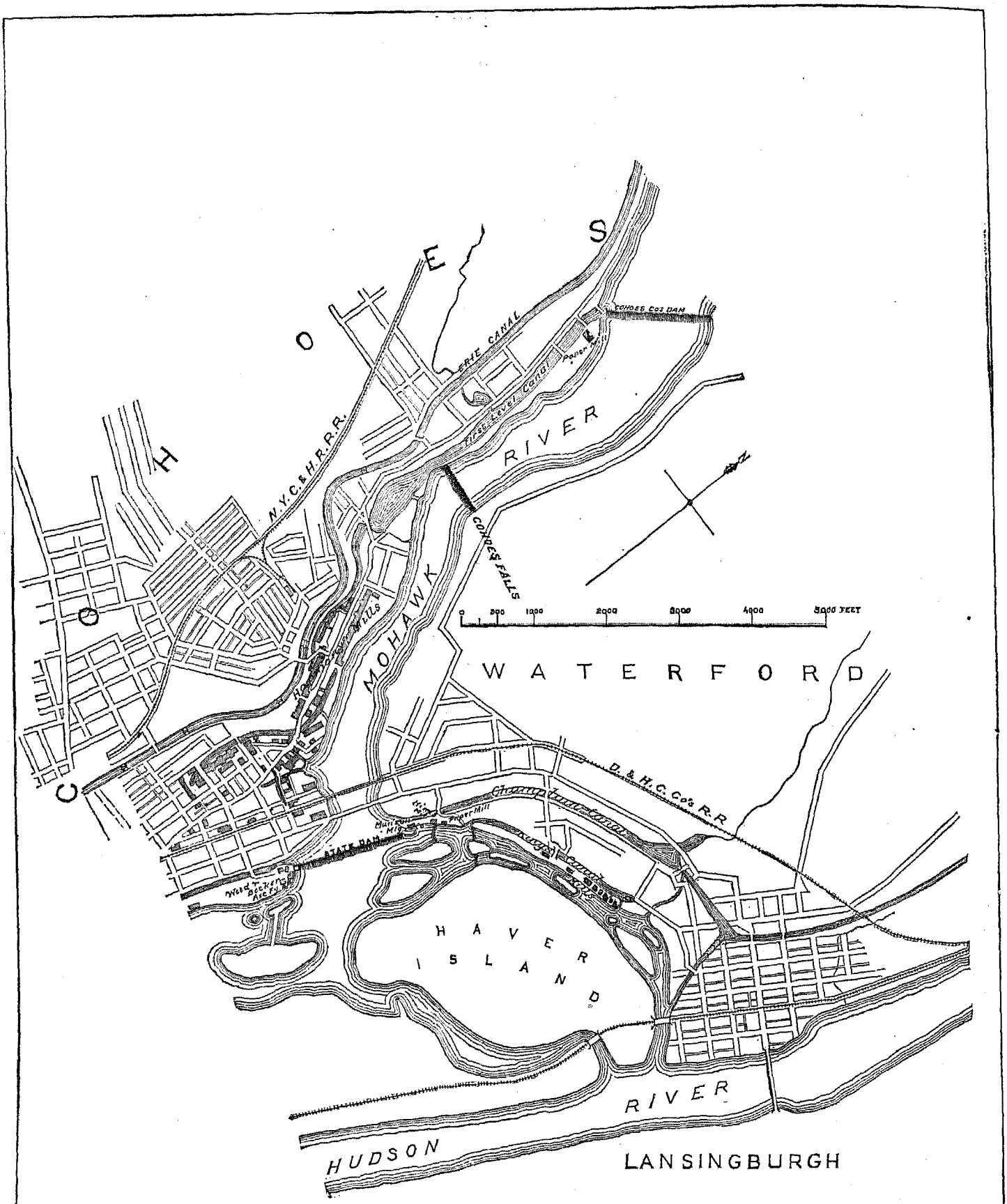

FIG. 6.—Map of Cohoes and Vicinity.

10 feet. It rests throughout upon rock ledge, and is strongly built of limestone masonry, having a width at base of about 13 feet and a front slope of 2 vertical to 1 horizontal. The coping-stones are 10 feet long with the stream, 3 feet wide, 2 feet thick, and the upper surface slopes down stream 1 vertical to 4 horizontal. The masonry of the dam is well bonded by headers and stretchers. The coping-stones are doweled together, and long drift-bolts unite them firmly to the body of the stone-work. At either end of the dam are masonry abutments, and a short distance above the gate-house a pier in connection with the old dam of 1831 serves as an ice-breaker. The cost of the new dam and its connecting work is stated to have been $180,000.

The bulkhead is of cut stone, and is surmounted by a neat brick building containing the machinery of the gates. Of these there are 9 connecting with the canal, presenting rectangular openings 8 feet by 9 feet in size and amounting in the aggregate to 648 square feet. These openings are covered by flat cap-stones, and separated by piers 3 feet thick. A tenth opening admits water to a turbine wheel of 20 or 30 horse-power used in operating the other gates. The gate-house contains also two overflow weirs of 36 feet each, discharging to the river; one opens from above and the other from below the bulkhead. There is another waste-weir, 80 feet long, immediately below the gate-house, opening from the canal to the river, and built of masonry. In addition to the 36-foot overflows there are two 9-foot gate-openings toward the river—one above the bulkhead, connecting the pond and river, and available for drawing down the former; the other below the bulkhead, and available for drawing down the canal.

The machinery for raising and lowering the gates is very easily operated and satisfactory in working. The turbine already spoken of is at the river end of the bulkhead, and operates three lines of shafting; one of these, 2¼ inches in diameter, runs in at right angles to the stream and connects with the head-gates; the other two run in either direction parallel to the stream and connect with the waste-gates. Each gate has attached to it two vertical iron posts with racks. Opposite one post of each gate is a pair of beveled friction-wheels revolving in parallel vertical planes; a third wheel, revolving in a plane at right angles to these, can by a small hand-wheel be brought in contact with either accordingly as it is desired to raise or to lower the gates. The turbine is started and sets in motion the long horizontal shaft and the odd friction-wheels; in the manner just described the motion is now communicated to one of the adjacent friction-wheels, which is thus made to revolve, and with it its iron shaft, having a worm-gear; this turns a large vertical toothed wheel, on the axle of which is a smaller toothed wheel directly engaging the rack, which is firmly connected with the gate. On the same axle is another toothed wheel, opposite to, and engaging, the other rack of the same gate.

So far as obtaining the full benefit of the fall at Cohoes is concerned the privilege is very thoroughly developed. Near the dam the Cohoes Straw Board Company draws a small amount of water from the upper level under 8½ feet fall, and discharges into the river; but, so far as was ascertained, that is the only exception to the water being used over and over again from different levels until finally discharged from the lowest canals into the pool above the state dam. Nine separate canals are in use, as follows:

No. 1 runs from the dam about 1 mile in a course approximately parallel to the river. It is 80 feet wide at the water-surface, with an average water-depth of 10 feet. (*a*) With the exception of pumps for the city water-supply, the only use of power on this level is by the Harmony mills. The fall to No. 2 is 18 feet.

No. 2 is about half a mile long, and is used entirely by the Harmony mills. It is 60 feet wide by 8 feet deep, with a fall to No. 3 of 25 feet.

No. 3 is about three-quarters of a mile long, and is used by 20 or 30 mills. It measures 60 by 9 feet, and has a fall of 22.7 feet to the level of canal No. 4. It also discharges with the same fall into canal No. 5, which is carried 1,000 feet in an underground arched way and used merely as a conduit.

Nos. 4, 5, 6, and 7 are all on the same level. No. 4 is about 1,200 feet long and 30 by 6 feet in cross-section. No. 5, already mentioned as running underground, is 25 feet by 8 feet. No. 6 is 1,000 feet long, 20 feet wide, 8 feet deep, with a fall of 14 feet to No. 9. No. 7 is say 800 feet long, 30 feet wide, 8 feet deep, with a fall of 19 feet to No. 8.

No. 8 is about 800 feet long, 20 by 8 feet in cross-section of water-way, and has a fall of 19 feet to the river.

No. 9 is 20 feet wide, 10 feet deep, with a fall to the river of 24 feet.

Cohoes is built upon a foundation of solid rock, through which the canals have to a large extent been excavated; where they do not have natural rock walls, artificial ones of stone or timber have been built. The mills are located in some cases upon the margin of the level from which they draw water, in others beside the level to which they discharge, receiving their supply from the higher canal through trunks or flumes. An interesting contrivance for getting rid of ice in the upper level should be mentioned. Canal No. 1 terminates in a "dead end" at the Harmony mill, and ice accumulates there in winter and is liable to cause serious trouble unless removed. To effect this a shaft was sunk there 40 feet deep in the rock, and connected by a tunnel with the river. This tunnel is 7 feet high at the center, 5 feet wide at the base, and descends by a grade of 1 in 12; it is 375 feet long, and in its course passes successively under canals Nos. 2 and 3. Through two gates, each 5 feet square, a very heavy rush of water can be caused from the canal down the shaft and out through the tunnel to the river, and by this means the canal is successfully and easily cleared of ice such as would be likely to cause trouble.

a The dimensions vary slightly along all the canals, but at the water-surface and for the water-depths are substantially as given.

The Cohoes Company, which is the proprietor of the water-privilege here described, also owns the land adjoining its canals, and to manufacturers gives perpetual lease of land and power, the property remaining subject to a lien of $200 per annum per mill-power; the land may thus be regarded as given outright, and the rental as applying only to the power. Formerly the standard for measuring water here was 100 square inches, which was to be measured through an aperture in thin plate, 50 inches wide, 2 inches deep, and under a head of 3 feet from the surface of the water to the center of the aperture. In 1859 a series of measurements were carefully made, using an old canal lock, and it was found that the old standard corresponded to about 5.9 cubic feet of water per second. Six cubic feet per second, however, was fixed upon and accepted by the lessees as a new standard, and that amount of water under 20 feet head, or its equivalent, constitutes a "mill-power". In order to determine the amount of water used, both weir and flume measurements, in accordance with Francis' formulæ, are employed. The measurements are not made at regular intervals, but whenever there are changes in the wheels, or oftener if for any reason it seems desirable. The cost of water-power at Cohoes, assuming varying degrees of efficiency for the wheels, is shown in the following table:

Table showing the cost of water-power at Cohoes.

Assumed efficiency of wheel.	Equivalent of 1 mill-power in effective horse-power.	Corresponding cost per effective horse-power.	Assumed efficiency of wheel.	Equivalent of 1 mill-power in effective horse-power.	Corresponding cost per effective horse-power.
Per cent.			*Per cent.*		
60	8.18	$24 45	75	10.22	$19 57
65	8.86	22 57	80	10.91	18 33
70	9.54	20 96	85	11.59	17 26

NOTE.—A mill-power costs $200 per annum, and corresponds to 6 cubic feet per second under 20 feet head, or 13.63 theoretical horse-power. The price stated covers also land necessary for building-purposes.

The permanent power of the privilege not yet being fully employed, the question of surplus powers has not assumed importance.

The growth of Cohoes has been great, and certainly warranted by the admirable advantages which it presents for manufacturing by water-power. As shown above, the rates for permanent power are very favorable, and the substantial character of the hydraulic works, together with the able management under which they are conducted, gives assurance to mill-owners that no ordinary disaster can interfere with their receipt of a full and uniform supply of water. The shipping facilities could scarcely be surpassed. For the greater part of the year there is the best of water communication in three directions: South, about 154 miles to New York, by way of the Hudson river from Troy or Albany; west and north, by the Erie and Champlain canals, respectively, which pass through the city. Railroad communication is afforded by the lines of the New York Central and the Delaware and Hudson railroads, reaching out in the same general directions as the water-routes, and also connecting with New England and the coal-fields of Pennsylvania.

It is said that in 1830 there were not more than 150 inhabitants within the limits of the present city. An attempt had been made at manufacturing as early as 1811 by the Cohoes Manufacturing Company, but the enterprise failed and the property was sold to the Cohoes Company. This company was incorporated March 28, 1826, with a capital stock of $250,000, which was increased in 1833 to $500,000. At first the company itself engaged in manufacturing as well as in supplying power to others, but afterward restricted its duties to the latter undertaking. In 1880 the population of the city had reached 19,416.

The pond above the dam extends from 1 to 1½ mile up stream, with an average width estimated at about 1,200 feet, and is seldom or never drawn down more than 2 feet below the crest of the dam. The Cohoes privilege is commonly rated at 120 feet fall, and a minimum, corresponding to that fall, of 10,000 effective horse-power. The actual fall developed, however, as shown by the descent between the various levels, is between 103 and 104 feet. It is stated by the officers of the water-power company that under all ordinary conditions 2,000 effective horse-power can uniformly be relied upon with 24 feet fall. It is probable, however, that in very exceptional circumstances the power may temporarily fall slightly below the limit mentioned. Mr. David H. Van Auken, hydraulic engineer of the Cohoes Company, gives the lowest discharge of the Mohawk during his long experience with it at this locality as from 800 to 1,000 cubic feet per second continuous flow for the 24 hours. If we assume a fall of 104 feet, a flow of 800 cubic feet per second, and a wheel efficiency of 75 per cent., then the minimum power of the privilege as at present improved will be represented in round numbers by 7,000 effective horse-power. In 1880 a total of 6,556 horse-power of wheels was returned by the census enumerators as in use from the Mohawk at Cohoes. The company still has permanent power to lease on its lower levels, canals Nos. 7 and 8 being yet open a quarter of a mile each for building-purposes.

Estimate of the flow and power at Cohoes.

Stage of river.	Rainfall on basin.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		Effective horse-power utilized.
	Spring.	Summer.	Autumn.	Winter.	Year.					
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	*1 foot fall.*	*10 feet fall.*	
Minimum flow	9½	12	9½	9½	40½	3,490	800+	90.88+	9,450+	a 6,556
Low water, ordinarily dry year							900	102.24	10,630	
Low water, average year							1,050	119.28	12,400	
Available 10 months, average year							1,600	181.76	18,900	

a In 1880. Up to the fall of 1882 the power in use was stated to have increased by perhaps 300 horse-power.

First in importance among the Cohoes industries, and the one requiring the principal use of water-power, is that carried on by the Harmony Mills Company, the most extensive manufacturer of print-cloths in the United States. This company gives employment to 3,700 hands, runs 6,200 looms and 280,000 spindles, and produces 125,000 pieces, at 45 yards each, per month. In the largest mill, No. 3, are 2,650 looms and 125,000 spindles. The main building of this mill is 1,170 feet long, with a wing of 210 feet, is 70 feet wide and 5 stories high. The company has a local monopoly in the manufacture of cotton cloth. Next in importance is the manufacture of knit goods, which began its history in this country at Cohoes in the year 1832. The invention of the knitting-frame, by Timothy Bailey, gave a great impulse to the business, which has since wonderfully developed. It is stated that in the fall of 1882 there were 18 knitting-mills at Cohoes, running in the aggregate not far from 130 sets of machinery and giving employment to nearly 2,500 hands. The Cohoes Rolling Mill has extensive works, and other establisments are engaged in the manufacture of machine work, paper boxes, straw-board, bobbins, cotton-batting, sashes, doors, and blinds.

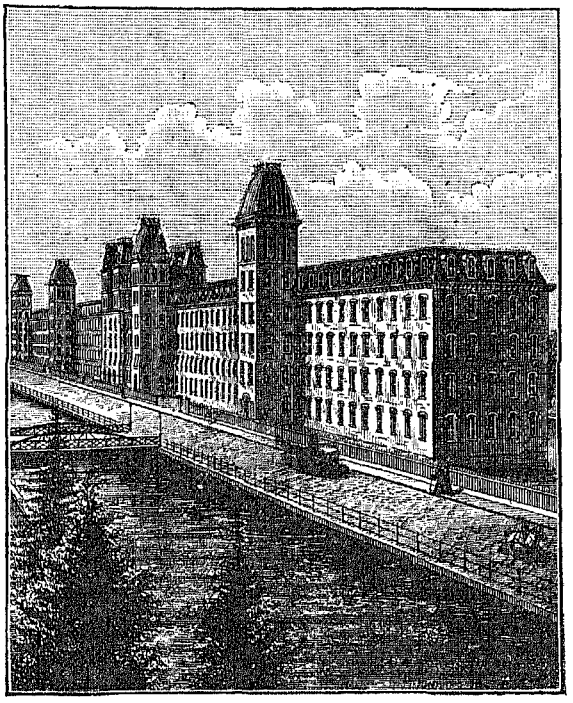

FIG. 7.—*Harmony Mill, No. 3.*

The Mohawk above Cohoes.—The next important fall is at Crescent, 1½ or 1¾ mile above the Cohoes Company's dam. The Mohawk is there 1,100 or 1,200 feet wide, and near the head of the rapids is crossed by the Erie canal on what is called the "lower" aqueduct. Rocky rifts extend about half a mile along the stream, with a fall stated to be 14 feet. The river runs shallow down these rifts, except for a width of perhaps 150 feet near the head, where there is a low-water depth of 5 feet. The material of the river-bed is a hard slate rock, becoming shaly toward the foot of the shoals. The south bank is rocky and abrupt, while that on the north has a moderate slope and is composed of earth underlaid by rock.

A short distance below the aqueduct a rude leaky wing-dam a couple of feet high runs out obliquely into the stream about 260 feet, and then strikes up stream to the aqueduct. Water is thus diverted into the race, which is 600 feet long and from 15 to 20 feet wide. It extends down the north bank of the river to a point where the available fall ranges from 5 to 8 feet, according to the stage of water. The power is used by L. W. Mansfield for a 3-run grist-mill and a little saw-mill. Only a small portion of the flow of the river is commanded by the rude works, and in a low stage enough water is obtained for only one wheel. Mr. Mansfield owns on the north bank the whole length of the shoals, and claims that a dam 4 feet high at their head would give 16 feet fall at a point say 300 feet below the present mill. Judging from the table of elevations which has previously been given, and from the falls in use at Cohoes and below, the fall at Crescent would appear to be naturally not more than 8 or 10 feet, or, with a dam 4 feet high at the head of the shoals, 12 or 14 feet. Considering the width of the river, the probable expense of improvements, and the absence of any direct railroad facilities, the power to be obtained seems hardly large enough to render the privilege an attractive one.

Estimate of power at the lower aqueduct.(a)

Stage of river.	Flow per second, average for the 24 hours.	Theoretical horse-power.				Effective horse-power utilized.
	Cubic feet.	1 *foot fall.*	12 *feet fall.*	14 *feet fall.*	16 *feet fall.*	
Low water, dry year	900	102.24	1,230	1,430	1,640	Perhaps 25 or 50.
Low water, average year	1,050	119.28	1,430	1,670	1,910	
Available 10 months, average year	1,600	181.76	2,180	2,540	2,910	

a Available fall not definitely ascertained.

The heavy ice runs which visit the Mohawk are sometimes particularly noticeable in this part of its course. In the spring of 1882 a gorge formed at some point below Schenectady, gave way suddenly, and in three-quarters of an hour the river rose nearly 3½ feet at Crescent, sinking away afterward almost as fast. By this rise the bulkhead and a part of Mansfield's dam were destroyed.

Above the shoals at the lower aqueduct there is 3 miles of smooth water, continuing very nearly to the privilege occupied by the West Troy water-works. The dam at that point runs out from either shore to an island in mid-stream, and has a lift of about 5 feet without flash-boards. It was built about the year 1877, and is a log structure filled in with stone. The apron is most of the way 10 feet wide, but for 60 or 70 feet next the right bank it extends in an irregular shape to an extreme distance of 75 feet down stream from the main portion of the dam, and is covered for 20 feet with squared timber, and the rest of the way with round logs from 6 to 10 inches in diameter, the interstices filled in with loose stone. The dam runs out from the left bank to the head of the island, and the other section reaches on from the foot of the island to the right bank. With 6-inch flash-boards the head obtained is 8 feet. Two wheels are run, one of 40 and one of 60 horse-power, and water is pumped to a distant reservoir for the supply of West Troy and Green Island. In spring, and sometimes in fall, a stoppage of the wheels is forced, even for as much as a week at a time in some seasons, by backwater.

Between the New York Central Railroad crossing at Schenectady and the lower aqueduct there is a fall of about 52 feet in a distance of 14.8 miles. Ascending from the water-works privilege toward Niskayuna the river runs through meadows well cultivated and apparently 1 or 2 miles in width. The current is sluggish and the channel is divided by islands. Not far above Niskayuna the meadows disappear and there is a continuous shoal for a mile, more or less. The banks are much of the way rocky and abrupt. The bed appears to be rock, with some gravel covering it. Above this shoal there is a succession of smooth reaches and riffles on to the upper aqueduct, at Rexford Flats. The fall on all these shoals is quite uniform, and at only a moderate rate.

At Rexford Flats the Erie canal again crosses the Mohawk, on an aqueduct of fourteen arches, and then descends in a short distance through two locks to a 3-mile level, which is fed from the river above. The width of the river at the aqueduct and above ranges from 600 to 700 feet. The surrounding country is hilly, fertile, well cultivated, and has but a moderate amount of timber. The feeder-dam is of stone with a sloping timber apron 10 or 11 feet wide. The fall, without flash-boards, is 6 feet. The abutments are of cut-stone masonry. The feeder is from 25 to 30 feet wide and runs down the left bank, striking the main canal nearly a mile below. No power is in use at this fall.

The banks here appear to be composed of alternate layers of shale and harder slate. The river-bed is covered with loose stone, probably underlaid by ledge. Below the aqueduct the river is perhaps 500 feet wide, and has steep rocky banks rising high and precipitous from the water on the right side, and becoming so on the left a short distance down stream, leaving room there for only the canal. Immediately above the aqueduct a road-bridge crosses the Mohawk. The floor planks of this bridge are 23 feet above low water, but years ago the river is said to have risen almost even with them, and even now freshet-rises of 10 or 15 feet are not uncommon.

From this point on to Little Falls the river preserves substantially the same general features. It has but a moderate slope, and runs usually with smooth surface, broken here and there by short riffles over gravelly shoals. At Tribes Hill the width between banks is somewhat over 500 feet. From the stream there generally stretch out meadows of varying width, beyond which there is a gradual rise to the hills that inclose the valley; occasionally the hill-slopes reach entirely to the river and the meadows disappear.

Four and a half miles below Little Falls the Mohawk is again drawn upon to supply the Erie canal, which it does through a feeder 3¼ miles long. The feeder-dam is of masonry, with ashlar-faced abutments rising 8 or 10 feet above the natural crest. Wide meadows border the stream on both sides. The dam has a lift of 3 feet, increased to 5 feet by flash-boards, and sets back the river as far as Little Falls.

Power at Little Falls.—The hills here close in, the meadows cease for a time, and the stream is confined in a narrow, rocky, and wonderfully picturesque little valley. Entering this pass, the New York Central railroad and a carriage-road skirt the left bank, while on the opposite side are crowded the Erie canal and the new West Shore railroad. Huge ledges appear in the river bed and banks and in the valley sides. Down near the river the

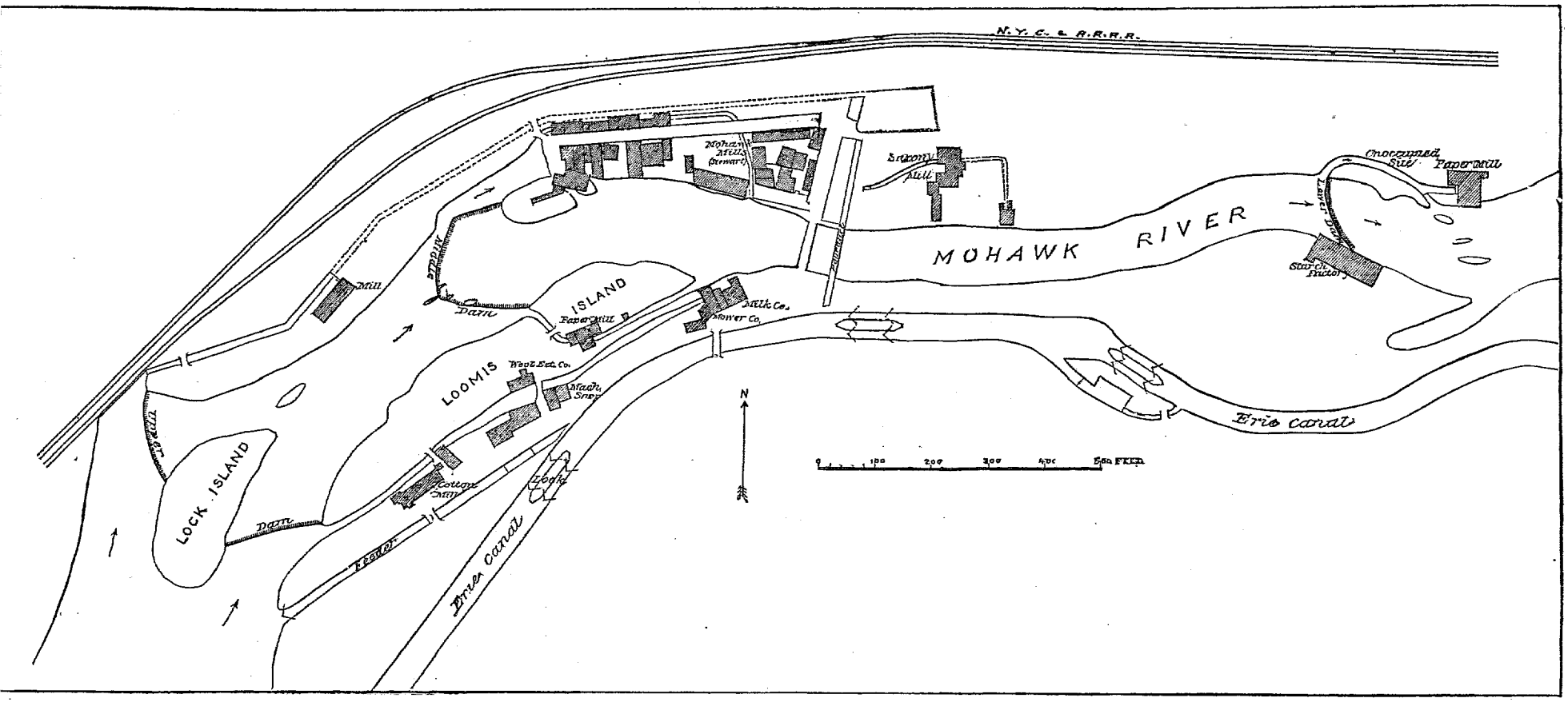

FIG. 8.—Plan of Water-Privileges at Little Falls.

prevailing rock seems to be a pinkish granite. Pot-holes are to be seen in this rock far up on the river-banks, 200 feet distant from the water, and it is said that they exist even on the very tops of the high hills which shut in the valley. The Mohawk has a rapid descent through Little Falls, amounting to about 45 feet from the surface of the pool above the state dam down to slack-water below the lower falls, a distance of from 2,500 to 2,600 feet. In this interval it is dammed and used for power at three different points, an aggregate of about 1,300 horse-power of wheels being employed for manufacturing purposes.

The first or lowest dam in order is a log structure consisting of several sections of varying height, running in an irregular line from the left bank across and down stream to the opposite bank. At the left or north end is a bulkhead of rubble masonry 33 feet long, 7½ feet wide, and 12 feet high above the tops of the gate-openings, which are arched. The admission of water is controlled by seven wooden gates operated by levers. A canal runs from the bulkhead 450 or 500 feet to a mill, and is inclosed in part by a natural ledge and in part by an artificial wall of dry stone. The privilege on this bank includes half the flow of the river and is divided into two equal shares. One of these is owned by Judge A. Loomis, of Little Falls, and is unoccupied. It would furnish a good power most of the year, presents a favorable building-site, and is for sale or rent. The other share is owned by E. B. Waite & Co., who have a mill for the manufacture of manila paper, with a capacity of 2½ tons per day. They obtain 11 feet fall, and estimate that they actually use about 125 horse-power. During the dry autumn of 1882 they were short of water more or less of the time at night.

That half of the privilege on the south side of the river is owned by the J. J. Gilbert estate. The Little Falls Starch Works, also operated under the old firm name of J. J. Gilbert, use 8 feet fall and two wheels—one of 20 and one of 30 horse-power. They employ 14 hands, and manufacture about 3,000 pounds of starch daily. One hundred and twenty horse-power is leased to the Parker Electric Manufacturing Company. Below this fall the river becomes comparatively sluggish, and spring high water sets back so as to stop the mills for a day or two at the privilege just described. A more serious difficulty encountered is from ice. Gorges form in the river a short distance below, throw the water back, and in some seasons cause a stoppage of the mills for two or three weeks. Many years ago they were even forced to shut down all of one winter.

At the site of the second or middle dam the river-bed is a mass of ledge rock worn full of pot-holes. The dam itself is a rough log structure running across in a very irregular line, projecting well up stream, and with a long wing extending down from the bulkhead on the north side, and forming for some distance the river support and overflow for the race. The main canal and the principal use of power are on that side, but a short race leads also down the south bank. The power on this latter side is owned by Judge Loomis and rented or leased to the present user. There are two falls, of 12 and 7 feet, respectively, at which a total of about 80 horse-power is used by William Kingston in a small last-factory, and a larger mill for the manufacture of straw wrapping-paper with a capacity of 1 ton per day.

At the north end of the dam water is admitted to the race through a wooden bulkhead, and is carried 800 or 900 feet down the river-bank, supplying, under falls ranging from 11 to 20 feet: Trask Brothers' ax factory, using 100 horse-power; the Henry Cheney Hammer Company's works, having 2 wheels of an aggregate of 110 horse-power, though the entire amount is not used; the mills of the Saxony Knitting Company and Messrs. Ablett, McKinnon, & Co., the former running 6 and the latter 2 sets of machinery on knit underwear; 3 saw-mills, a 5-run flouring-mill, and one or two other small concerns. Perhaps midway along the race there is a plot belonging to the estate of the late A. T. Stewart, of New York, and occupied by extensive stone mills formerly used in woolen manufacturing, but now vacant. Immediately below is an unoccupied site owned by Victor Adams. Owing to the fact that part of the water from the upper fall is discharged into the river below the middle dam, the privilege just described has a less supply than either the one above or the one below, but for the greater part of the year there is enough for the works now in operation.

The third or upper dam is a low affair, from 2 to 4 feet high, built of logs, rude and leaky; it extends from either shore to an island, and has a slight curve up stream. On the north bank the only use of power is by the Little Falls Knitting Mill Company, running 9 sets of machinery in the manufacture of knit underwear. Water is brought several hundred feet from the dam through what was either the old Erie canal or a feeder to it. The mill obtains 5½ feet fall and has two 25 horse-power wheels. The supply of water is short in summer, and steam is used all the time for auxiliary power. On the south side of the river the pool above the dam is drawn upon not only by an hydraulic race, but also by a feeder to the Erie canal. Water is admitted to this feeder through an opening of 23 feet in the clear, between walls of cut-stone masonry. The draught for canal purposes is tolerably uniform through the boating season, but naturally varies somewhat with the volume of business.

The entrance to the hydraulic race is through an arched bulkhead of heavy masonry. The main portion of this is 75 feet long, 11 feet wide, and rises 7½ feet above the top of the arch. Water enters through 7 gates and passes perhaps 200 feet to the upper mill. This is the Little Falls cotton mill, running 5,750 spindles and 122 looms in the manufacture of prints; 7 feet fall is obtained, and power taken from one wheel of about 75 horse-power. There is at times a slight scarcity of water, though it is thought there would be plenty with a tight dam. After leaving the cotton-mill the water passes down through a race, over two successive falls, and supplies power first to

Reddy's machine-shop and the works of the Little Falls Wool Extract Company, and secondly to the Warrior Mower Company's factory and an establishment for the manufacture of condensed milk; the middle fall is from 6 to 8 feet and the lower from 11 to 12 feet.

The Mohawk above Little Falls.—Above the section already considered the Mohawk is a sluggish stream, having a fall of only 68 feet in the 37½ miles below Rome,(*a*) and flowing through a wide open valley, rich agriculturally, and devoted to the raising of potatoes, wheat, corn, hops, and other products. The first dam above Little Falls is at Rome, where an important draught is made by the state for feeding the 56-mile level of the Erie canal. To accomplish this there is a low curving dam of cut-stone masonry which diverts water through a feeder. The river is in that vicinity about 120 feet wide, with gravelly bed and low banks. A short distance above Rome there is an old log dam forming a pond of a few acres from which water is pumped to a distributing reservoir for the supply of the city; the fall at the dam is made use of to furnish power for pumping, and two wheels, of about 100 horse-power each, are run under a head of 10 or 12 feet. No information was gained of any important power, either improved or unimproved, on the river above this point, and its only use seems to be by a few small flouring- and saw-mills. Some wastage is said to be received from the Black River canal, but the latter serves mainly as a feeder to the Erie, which it joins at Rome. The Erie also receives a considerable amount of water from large reservoirs in the Black River basin, which is diverted to the upper Mohawk, through the Lansing kill, some 23 miles by river above the Rome feeder-dam. From a distance of a few miles above Rome the country on to the head-waters is described as rough and hilly.

Drainage areas of the Mohawk river. (*b*)

	Sq. miles.
At Rome	184
At Utica	524
At Little Falls	1,272
Below the mouth of Schoharie creek	3,122
At the mouth of the Mohawk river	3,493

TRIBUTARIES OF THE MOHAWK RIVER.

Schoharie creek.—This stream rises in the southern part of Greene county at a distance of 10 miles westerly from the Hudson river. It runs northwesterly 16 or 18 miles by general course, and then northerly about 50 miles to the Mohawk, which it joins at Fort Hunter. The drainage basin includes 308 square miles at Gilboa, 684 at Central Bridge, above the Cobleskill, and 947 square miles at the mouth. Within this area are comprised the greater part of Schoharie county, and portions of the counties of Greene, Albany, Delaware, Otsego, Montgomery, and Schenectady. The Delaware and Hudson Canal Company's railroad runs from Albany at right angles to the direction of the stream, and crosses at Central Bridge, but otherwise the immediate valley is not accessible by railroad except at the extreme head-waters. The upper course of Schoharie creek drains the western and northern slopes of a portion of the Catskill mountain range, some of the higher points of which rise to altitudes above tide of 3,000 feet and over. From the head-waters to the central part of Schoharie county the surrounding country is rough and broken, with steep slopes; farther north the hills are more rounded and are arable to the very summits. When this section of country was first settled agriculture was mainly confined to the river-flats, the hills being reserved for woodland; but, it having been discovered that the hills are covered with as fertile a soil as is found in the valleys, they were speedily stripped of the greater part of their timber, which is now confined to limited patches. In the central and southern parts of Schoharie county, and on to the upper waters, the prevailing soil is a clayey and sandy loam containing considerable lime, while farther north there is less sand.

At the Delaware and Hudson Railroad crossing at Central Bridge the water-surface of the creek is 560 (*c*) feet above mean sea-level; immediately below the state dam, near the mouth, the corresponding elevation is 274 (*d*) feet, indicating a fall of 286 feet in the intervening 19 miles, or an average of about 15 feet per mile.

So far as was learned concerning the principal portion of its course, that below Schoharie village, the creek has but little value for water-power, although it can and does sustain some small grist- and saw-mills. It is bordered by alluvial flats subject to overflow, accomplishes its descent chiefly in riffles and shoals without abrupt falls, runs very low in the dry season, and is subject to heavy freshets and ice-runs. Just above the mouth the state draws upon the stream to feed the Erie canal, the estimated supply from this source being about 113 cubic feet per second;(*e*) when visited November 15, 1882, the pool had thus been drawn down 18 inches below the crest of the feeder-dam, and even the small mills within a few miles above complain of a scarcity of water in the dry season. The unusually low volume to which the stream sinks can probably be explained by the cleared and cultivated condition of much of the country drained, the steep slopes in the upper basin, the absence of any

a From the crest of the Rome feeder-dam to the crest of the Little Falls feeder-dam.

b Natural drainage areas, not including the district made artificially tributary from the Black River basin.

c 555 feet + tide-water at Albany (mean-tide = 4.84 feet + mean sea-level).

d From Erie Canal profile.

e See *Annual Report of the State Engineer*, 1880, page 38.

sustaining ponds or reservoirs worth mentioning, and the fact that, in Schoharie county at least, much of the surface is underlaid by cavernous limestone rocks through which there is a loss by percolation. On the occurrence of heavy storms there is a rapid rise followed by a speedy fall, very high water lasting but two or three days in the lower course. At Mill Point, 3 or 4 miles from the mouth, a rise of 4 feet in 6 hours is said to have been observed. The common freshet-rise in that vicinity is not, however, over 6 or 7 feet.

In ascending the stream the first dam encountered is a couple of thousand feet above the mouth, and is owned by the state. It is about 540 feet long and has a lift of 6 feet. There is a flat slope each way from the crest, that on the down-stream side being 26 feet long and serving as an apron. The dam is of heavy timber, but is evidently old, and is considerably battered. For 120 feet next the west bank the apron is prolonged 15 feet still farther from the crest than above mentioned. The abutments are of masonry, and for some distance up stream and down, the river is walled with stone to a height of 8 or 9 feet above the crest of the dam. The stream-bed is here covered with loose rock, bowlders, and gravel, and a little way above, at the West Shore Railroad crossing, an excavation for the easterly pier of the bridge showed the same material to the depth reached, 7 feet. From the pool above the dam, water is admitted through a gate-way 17 feet wide to the feeder canal, which then runs easterly about 3,000 feet in a straight line to the main trunk of the Erie canal. The latter crosses Schoharie creek a few hundred feet below the feeder-dam on a stone aqueduct of 14 arches.

No water-power is employed at the feeder-dam, and the first use of the stream for that purpose is at Auriesville, perhaps a mile or more above. The mill is isolated, the surrounding district being rather sparsely settled by a farming class. The stream is here flanked by broad meadows of the greatest fertility. These are covered with a black alluvial soil, preserving the same character to a depth of 5 or 6 feet. For forty years these flats have been cultivated in broom-corn, oats, Indian corn, and barley without once being artificially enriched, yet they continue to yield splendid crops. On the uplands grass and all kinds of grain are raised. A considerable amount of timber is still standing in the adjacent country, embracing pine, oak, hemlock, with some maple and hickory.

At Auriesville the immediate valley is in the neighborhood of half a mile wide and is succeeded by a rise to rather low hills. The stream-bed is covered with loose rocks forming rifts; the fall on these is said to be slight, but they occur at intervals all the way from the state dam as far at least as Mill Point. For the mill-privilege a low line of rocks across the stream makes a shallow pool, from which, through a rude bulkhead with paddle-gates worked by iron rods and levers, water enters a small race and runs perhaps a quarter of a mile across the flats to the mill which is at the foot of the bordering hills. The mill is owned by Peter Veeder, has 3 saws and 3 runs of stone, power being taken from a 5-foot Lessner turbine, on which the head is 7 feet in a favorable stage of the stream. The water is returned to the creek through a tail-race of about the same length as the head-race. For two months in the year the supply of water obtained is insufficient for running the mill. On the other hand, freshet backwater also hinders. The stream usually floods the meadows during the spring rise to a depth of a foot or two, now and then entering the mill. In October, 1869, it rose high in the mill, and must have run 7 or 8 feet deep over the meadows. Ice generally collects below at the state dam, and a few years ago a gorge formed there which stopped Veeder's mill by backwater for ten days. Ice also runs out on to the flats and leaves considerable deposits of gravel.

At Mill Point, 3 or 4 miles above the mouth of the creek, James J. Faulkner has a 4-run grist-mill, a small saw-mill, and a broom-handle factory, at which not less than 200,000 feet of lumber is stated to be annually worked up. Seven water-wheels are run, old-style iron turbines, estimated at about 140 horse-power total capacity. The entire fall on the privilege is 17 feet, but of this 3 feet is taken up in the races. The stream makes a long bend here, across the base of which water is conveyed to the mills in a head-race say 60 rods, and discharged through a tail-race 8 rods in length, while the intervening distance by river is estimated at about a mile. At the site of the dam the bed is covered with gravel and bowlders; a steep clay bluff rises on one side, and on the other there is a more gradual ascent to a flat. The dam runs diagonally up stream, and in a very low stage of water serves to divert most of the flow into the race. It is a timber structure part of the way across, filled in with stone and planked, and has stood for about twenty years. On one bank, the left, it abuts against a wall of dry bowlders, but toward the other bank the timber portion ceases and is succeeded by a low line of stones loosely piled up. The pondage is insignificant. In ordinary years the supply of water obtained answers the demands of the mills, but it is so held back in mill-ponds above as to come down irregularly, and in a very low stage it is thought that the entire volume of the stream would not run all the wheels. A rough estimate of the available power shows the following result:

Estimate of power at Mill Point.

Stage of river.	RAINFALL ON BASIN.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.			Effective horse-power utilized.
	Spring.	Summer.	Autumn.	Winter.	Year.						
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	*1 foot fall.*	*14 feet fall.*	*17 feet fall.*	
Low water, dry year	10	12	9½	8½	40	942	70	7.95	110	140	150±
Low water, average year							100	11.36	160	190	
Available 10 months, average year							200	22.72	320	390	

At this locality the creek-bed is variously composed of clay, loose rock, and ledge rock. The common freshet-rise is not more than 6 or 7 feet, and is said not to overflow the flats except when ice-gorges form. As far as Esperance, 10 miles above, the stream is described as uniformly rapid, though without heavy falls, and above that point as flat. In the distance named it is bordered by bluffs, opposite to which are bottoms of from 50 to 100 acres, and its course is very winding; then there are bottoms on both sides up to Schoharie. In the vicinity of Mill Point the bluffs are of blue clay, but at other points slate rock. Schoharie village is the most important point directly on the stream, and has a population of 1,200. The creek has there an average width of about 250 feet, alluvial banks, and a somewhat gravelly bed; in summer it runs shallow and with scarcely any current, but after a long-continued rain it becomes swollen to a fierce torrent and overflows far and wide the adjacent low lands.

East Canada creek.—This creek has its source among the mountains in the southwest part of Hamilton county within a few miles of Piseco lake. It flows southerly and joins the Mohawk 6½ miles below Little Falls, in its course passing across a corner of Fulton county, and then forming the boundary between that county and a part of Montgomery on the east and Herkimer on the west. The drainage basin contains an area of 299 square miles, and the stream has a length of about 26 miles by general course. When visited in the middle of November, 1882, after a season of unusual drought, East Canada creek was carrying an important volume of water. It must be a valuable feeder of the Mohawk, and would make a fine water-power stream, the principal trouble being that at numerous points where there is a large fall the ground is not well suited to building on account of the steep banks and narrow valley. The land immediately adjoining the lower course is timbered with small hemlock and other trees, but the surrounding country has been pretty thoroughly cleared. The latter is quite broken for the first 3 or 4 miles north of the Mohawk, but then becomes more regular though still rolling. The fall in the creek is rapid, and from Dolgeville, 6½ miles above the mouth, to Little Falls, the descent is said to have been shown by a railroad survey to be about 500 feet.

The stream is not employed for logging, although timber is cut near the head-waters and floated down the Sacondaga. Spruce is the main variety now left; the hemlock has been chiefly cut away, but there is still abundance of hard wood. The water of the creek is largely derived from springs, is soft and very pure, never leaving any film or sediment in boilers. Numerous lakes are drained, of which the East Canada group, several in number, was mentioned as presenting good opportunities for storage. This group is distant 15 or 20 miles by road from Dolgeville. It is claimed that by raising the outlet to the lower lake the surfaces of all, which are connected upon nearly or quite the same level, could be raised several feet. The outlet of Feris' lake joins the main creek a short distance above Dolgeville, and it was stated that this lake could also be used as a reservoir, and if desirable raised 20 feet, overflowing only poor land. The lake is described as a mile or more long and of good width. The flow of the creek is tolerably well sustained in the dry season, but is becoming less so every year on account of the cutting away of timber. The fall is so rapid that freshets do not attain great height and soon run out. There is a run of ice in spring, but no damage is reported as resulting from that cause.

At the mouth the creek is about 200 feet wide between banks, but in a low stage the actual width of water-way is less. The lower course for say 3 miles from the Mohawk is through a narrow, rocky, and wooded valley, and contains a number of abrupt falls. One mile above the mouth the creek is said to descend 180 feet in three-quarters of a mile.(*a*) Between the mouth and Ingham's Mills was noticed a paper-mill recently built and not yet in operation. It is located at what are known as the "Beardsley" falls, where the stream pitches down over a series of ledges formed like a flight of steps. A wooden flume carries water to the mill and gives a head, measured to the surface of the pool below the falls, of about 25 feet. There are other falls unoccupied just below.

Three miles or thereabout from the mouth the valley becomes more open, the hills receding, and there are some farms; the banks are of moderate height, the bed consists of gravel or low ledges, and the fall is rapid but not so abrupt as below. This section could undoubtedly be used to good advantage for power.

At Ingham's Mills, between 3½ and 4 miles from the mouth, there are a 2-run grist-mill, a small saw-mill, a cider-mill, and a cheese-box factory. The water-privilege is improved by means of a log dam said to be a hundred years old, and a race some 60 rods long, and has about 10 feet fall. The mills can run at full capacity nine months in the year.

A quarter of a mile below Dolgeville there is a fine fall of 50 or 60 feet in a short distance, the theoretical power of which, assuming the entire fall as available, may be estimated as below:

Estimate of power at the falls one-quarter of a mile below Dolgeville.

Stage of river.	RAINFALL ON BASIN. [Roughly approximate; no data for accurate determination.]					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		
	Spring.	Summer.	Autumn.	Winter.	Year.					
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	*1 foot fall.*	*50 feet fall.*	*60 feet fall.*
Low water, dry year	9	13	10	8	40	269	70	7.95	400	480
Low water, average year							90	10.22	510	610
Available 10 months, average year							130	14.77	740	890

a See page 346, *Historical and Statistical Gazetteer of New York*, 1860.

At Dolgeville is the most important use of power on East Canada creek. From moderate beginnings the works have grown until they have now become quite extensive, giving employment to about 300 hands and carried on in two fine mills. The property is owned by Mr. Alfred Dolge, who manufactures felt, piano and organ sounding-boards, and has also a grist-mill. The felt-mill is a fine structure of stone, 260 feet long by 75 wide, while the sounding-boards are made in a wooden factory 200 by 40 feet in size. There are two log dams here, but only the upper one is used. A flume from 350 to 400 feet long carries water to the mills, where the extreme fall obtained is 20 feet. The estimated capacity of the wheels is a total of 290 horse-power. In the stone mill there is a 120 horse-power iron turbine, but the other wheels are wooden and of old patterns. The stone mill is also to have an engine of the same capacity as the wheel. The stream can be depended upon here for the entire amount of power needed in ordinary years, except during say July and August, and Mr. Dolge estimates that with 20 feet fall 100 effective horse-power can always be realized. Dolgeville is 6½ miles from the mouth of the creek, and is without railroad connections. A line has been surveyed, however, to run from Little Falls through Dolgeville, Devereaux, and on to Piseco lake.

West Canada creek.—Rising near the center of Hamilton county, between 45 and 50 miles north of the Mohawk, and 13 miles to the north of Piseco lake, this stream flows in a southwesterly direction from 38 to 40 miles by general course, and then on the eastern edge of the town of Trenton, Oneida county, turns and runs southeasterly and then southerly through a farther distance of 20 miles, emptying at the village of Herkimer. The source is in an elevated region whence also flow the Cedar and Indian rivers to the upper Hudson, and the Black river to lake Ontario. Its water-shed includes an area of 548 square miles, within which are many lakes, Transparent lake, the largest, being represented on French's map as about 4 miles long and a third of a mile wide. For about 15 miles from the mouth to Poland the Herkimer, Newport, and Poland railroad follows the immediate valley. The stream is also approached at Trenton by the Utica and Black River railroad, but the greater part of its course is not directly accessible by rail. The largest villages on the stream are Herkimer, at the mouth, 2,400 inhabitants, and Newport, 11 miles above, with 700.

There are no data at hand from which to give frequent elevations along the course of the stream. According to Colvin's *Survey of the Adirondack Region*, Transparent lake, which is not, however, the most distant source of the stream, is 2,187 feet above the sea. The track of the New York Central railroad at its crossing near the mouth is 403 feet above the same datum-plane, indicating an intervening fall in the water-surface of approximately 1,800 feet. So far as could be judged from a hasty examination, that portion of the stream below Prospect, in which the drainage area increases from 358 square miles to 548 at the mouth, is inferior to the lower portion of East Canada creek in value for power, except perhaps as regards the volume of flow. Below Trenton Falls the valley of West Canada creek is more open than the lower valley of the other stream, but the fall is described as being only moderate in amount. From Prospect down to the foot of the Trenton falls the descent is very great, but it takes place in a narrow chasm varying from 50 or 60 to much beyond 100 feet in depth, and frequently so contracted and rugged that improvement of the fall by ordinary methods would be impracticable. There are no artificial reservoirs, and the dry-season flow appears rather less well sustained than that of East Canada creek. Heavy runs of ice occur, and there are violent spring freshets, during which the flats near the mouth are submerged.

The first power in use, ascending the stream, is encountered at Herkimer, and is improved by a timber dam resting on gravel and rock. Several years ago one-quarter of the dam became undermined by overflowing water and was carried away. Water passes to the mills through a race 2 miles long, broadening out in one part to a lake half a mile long and a quarter of a mile wide. In the lower part this race is from 30 to 35 feet wide and 5 feet deep. The tail-race from the lower mills is at least half a mile in length. The water is used in two falls of 21 and about 14 feet, respectively. The upper fall, of 21 feet, is occupied by the Herkimer Paper Company, manufacturer of news and colored papers, producing 5 tons per day. About 150 horse-power is in use. The lower fall is nominally divided into square feet under 14 feet head, but the head actually obtained is said to range ordinarily from 13 down as low as to 10 feet. Power is used by a saw-mill, 2 sash-, door-, and blind-shops, a 4-run grist-mill, a plaster-mill, a knit-goods mill, and a furniture factory. There is in some years more or less scarcity of water for one or two months in summer; slight trouble is also experienced from backwater, and in some winters the mills are shut down several days by anchor-ice.

From Herkimer to Trenton Falls, some 20 miles above, the stream is described as in general wide, and running over a gravelly bed with rifts but no heavy falls. In this interval there are said to be no powers of consequence in use, except at Middleville and Newport, at the former of which places there are a grist-mill and a tannery.

At Trenton Falls the stream passes through a wonderful gorge in the hills, pitches abruptly down in a series of falls, and gives rise to the charming scenery for which the locality is famous. A considerable portion of the fall might doubtless be turned to avail for power, but the present owner of the property adjoining the principal falls is not in favor of any such encroachment upon the natural beauties of the place, and it would indeed seem like a desecration to supplant the charms of this favored spot by the homely surroundings of an ordinary manufacturing village.

The lowest available privilege is at the foot of the series of falls, and is occupied by William A. Morgan for a 3-run grist-mill. It is improved by a timber dam 212 feet long and 9 feet high, built in 1869 or 1870. A sudden

fall of 5 feet immediately below increases the head at the mill to 14 feet. There is always a wastage on the dam, and when visited, in a very low stage of the stream, there was 6 inches of water on the crest, the mill not running at the time. Five feet is the extreme freshet-rise seen on the dam during a number of years. Two years before it was rebuilt the original log dam was carried out at each end. The pondage obtained here is very small. Ice is thoroughly broken up in coming down through the gorge above, and goes over clear of the dam; some roots of trees are brought down at times, however, and threaten the structure. Freight rates are complained of as high at this point, and are said to be as much to Utica by railroad as by team. In the fall of 1882 they were stated to be 12½ cents per 100 pounds for ordinary freight between here and Utica, a distance of 16 miles, and for car-loads of grain, coal, and similar articles, 7 cents per 100 pounds.

The descent at Trenton Falls is commonly spoken of as 200 feet in half a mile, but exact figures as to its true amount could not be secured. Mr. Moore, owner of the land adjacent to the falls on each side of the stream, gives the fall at four of the principal pitches, in order ascending the stream, as follows: Sherman fall, 24 feet; High fall, 105 feet; Mill-dam fall, 14 feet; Suydam fall, 12 feet.

The sides of the chasm through which the stream runs here are steep, almost vertical, walls of Trenton limestone. Opposite the Mill-dam fall the banks are lower than elsewhere, and by sinking a wheel-pit and tunneling for the tail-race from the bottom, this fall could be combined with the High fall and a very large head obtained. At the top of the banks the ground is sufficiently level for the location of mills.

Estimate of power at Trenton Falls. (*a*)

Stage of river.	RAINFALL ON BASIN. (*b*)					Drainage area.	Flow per second, average for the 24 hours.	THEORETICAL HORSE-POWER.					
	Spring.	Summer.	Autumn.	Winter.	Year.			1 foot fall.	12 feet, Suydam fall.	14 feet, Mill-dam fall.	24 feet, Sherman fall.	105 feet, High fall.	155 feet, total of four falls.	200 feet, assumed total at Trenton Falls.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*							
Low water, dry year	9	13	10	8	40	360	80	9.09	110	130	220	950	1,410	1,820
Low water, average year							100	11.36	140	160	270	1,190	1,760	2,270
Available 10 months, average year.							150	17.04	200	240	410	1,790	2,640	3,410

a Probably not all available in any case, and the total fall uncertain, though commonly stated at 200 feet.

b Roughly approximate; no data for accurate determination. Observations for ten years at South Trenton give an annual rainfall of 54 inches, nearly 18 inches in excess of the amount as shown at Fairfield academy, 14 miles to the southeast and 350 feet higher than South Trenton, by records for 17 years.

The gorge continues from the lower mill-privilege, already described, about 2½ miles up to the Prospect privilege. Immediately above the property owned by Mr. Moore the land for half a mile up stream is owned by Mr. William Perkins. In this distance the cut made by the stream is about 60 feet deep, with steep sides, increasing in height as the lower limit of the property is approached; for a mile above this section the depth is said to average from 60 to 80 feet. The banks either rise directly to level land or consist of two or three shelves where quarried out. The stone is claimed to answer finely for building-purposes; it also takes a handsome finish and is suited to monumental work. It is largely quarried for these purposes and for making lime, and is obtained in blocks varying in thickness from 2 feet downward. There are twelve or fourteen thick layers, and thinner ones beneath. About 30 feet of fall has recently been sold by Mr. Perkins, and will be used for power on the right bank.

At Prospect, 3 miles by direct road from Trenton, there is a splendid privilege having a natural fall of about 22 feet, which could be purchased at a reasonable price. The stream descends in a beautiful sheet over a smooth, massive barrier of rock, at the summit of which a low timber dam extends about a third of the way across from the right bank. Its greatest height is not over 2½ feet, and it runs out on the rock. The banks are level and perfectly adapted to building. The half of the privilege on the left bank is owned by the firm of Hinckley & Blue, having extensive mills farther up stream, and is unoccupied. That on the opposite side is occupied by Henry Hogedorn for a grist-mill, and by Lewis G. Griffith for a tannery. Water is received through a race cut in the solid rock, not over 75 or 100 feet long, and is used under an effective head of 18 feet. The grist-mill has 3 runs of stone and 3 wheels, each of 30 horse-power, and the tannery has one 26 horse-power wheel. There is always a wastage of surplus water on the dam.

Estimate of power available at Prospect.

Stage of river.	RAINFALL ON BASIN. (*a*)					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.			Effective horse-power utilized.
	Spring.	Summer.	Autumn.	Winter.	Year.			1 *foot fall.*	18 *feet fall.*	22 *feet fall.*	
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*				
Low water, dry year	9	13	10	8	40	358	80	9.09	160	200	116 horse-power of wheels; probably not over 70 horse-power actually used.
Low water, average year							100	11.36	200	250	
Available 10 months, average year.							150	17.04	310	370	

a Roughly approximate; no data for accurate determination.

Two miles above Prospect, Messrs. Hinckley & Blue have what are known as the "gang mills". They are large mills having two gang-saws of 20 saws each and other machinery. Some 20 miles above are Hinckley's upper mills. Measured by direct course the stream has its source about 38 miles above Prospect. The valley is described as comparatively open for several miles up, after which the mountains are encountered and the slopes become in places very precipitous. For 26 miles above Prospect the adjoining country along the creek is cleared and settled, but from there up is thickly wooded.

Sauquoit and Oriskany creeks.—Sauquoit creek rises in the town of Paris, in the southeastern part of Oneida county, and runs northerly to the Mohawk, emptying a couple of miles above Utica. It is 30 miles long by general course, and drains 62 square miles. Near the mouth, at the Whitesboro' bridge, it is in summer about 80 feet wide, shallow, with a brisk current, and has low banks. It is without artificial storage reservoirs, and is very "flashy" and fluctuating in flow. The first use of power met in ascending the stream is at the extensive New York cotton-mills, about 2 miles from the mouth. There are three mills, or groups of mills, located at two distinct privileges. At the lower privilege, Mill No. 1 has a breast-wheel, 20 feet fall, and say 150 horse-power; Mill No. 2 has a breast-wheel, 30 feet fall, and 350 horse-power. At the upper privilege Mill No. 3 has 30 feet fall and from 300 to 350 horse-power. It is stated that the three mills can run at full capacity by water-power for three or four months in the year, but for the remainder of the time get only about one-third capacity from that source, and are obliged to rely upon steam. Manufacturing is carried on at half a dozen or more localities above on the creek, the principal productions being cotton, woolen, knit and silk goods, forks, and scythes. There were also, in 1880, several unoccupied privileges, of which there were mentioned in particular the old Brownell privilege, at the village of Sauquoit, factory burned; the Farmer's factory privilege, factory burned; and a privilege between Chadwick and Clayville.

Oriskany creek has its source in the town of Madison and county of the same name, whence it flows northerly till it reaches the Mohawk, 6 miles northwesterly from Utica. Its drainage area is 135 square miles. At the village of Oriskany, a short distance above the mouth, the state has a dam a few feet high and from 200 to 250 feet long, for diverting water to the supply of the Erie canal. While canal navigation lasts, usually from May to December, most of the water flowing down is thus used, and the mills just below have either to shut down or to run by steam. These mills have a private dam across the stream a short distance below the state dam, and receive their water through a long canal. The Oriskany grist-mill gets 80 horse-power with 10 or 11 feet fall. The Waterbury factory has 14 feet fall, and obtains 100 horse-power, except during the period of navigation, when steam is largely relied upon. Above the pool of the state dam there is another dam with 9 feet of fall not in use; the privilege was formerly utilized, and there yet stand the ruins of a brick factory which burned. Farther up stream are powers employed by grist-mills, one or two cotton factories, and the Kirkland Iron Works. The bed and banks of the stream are said to be generally of gravel. The flow is comparatively steady, there is no trouble from ice, and near the mouth the ordinary freshet-rise is reported as not over 4 feet.

THE HOOSAC(*a*) RIVER.

This stream, one of the largest tributaries of the Hudson, and, excepting perhaps the Mohawk, the most important in point of manufacturing, takes its source among the mountains in northern Berkshire county, Massachusetts. It first runs northwesterly, passing across the extreme southwestern corner of Vermont and into Rensselaer county, New York. Reaching the northern boundary of that county it turns and pursues an indirect westerly course, joining the Hudson opposite Stillwater. Its basin has an area of 710 square miles, and the river itself has a length by general course, below the junction of the North and South branches at North Adams, of about 40 miles. The principal affluents received are the Little Hoosac river, Walloomsac river, and Tomhannock creek. As well in New York state as at the head-waters in Massachusetts, the country drained is to a great extent rugged and mountainous, the summits of the Taghkanick and Petersburg ranges attaining elevations of from 1,000 to 2,000 feet above tide.(*b*) These mountains are described as having rocky precipitous slopes, and as being partially covered at the top with timber, though displaying many bare masses of rock. The Taghkanick range is mainly composed of slate, quartz, sandstone, and limestone; while the Petersburg mountains are made up of graywacke slates and limestone. The soil on the mountains is poor, but of fair quality on the less elevated lands and in the valleys, and in the vicinity of Schaghticoke are fine corn-lands. Wheat, oats, potatoes, and flax are also raised in different sections, and grazing and dairying are extensively conducted.

The immediate valley of the lower Hoosac lies in a moderately hilly, open country, which is good farming land even to the tops of the hills and is well cultivated. In the vicinity of Hoosac Falls the surrounding country grows more hilly, and at Pownal, and above to the source, the valley is inclosed by high, steep, and rocky slopes, well covered with a young growth of timber. From Hoosac Falls up to North Adams, directly adjacent to the stream are fertile meadows, and the banks are rather low. Above Pownal these meadows do not often appear to exceed half a mile in width between the hills, and they were judged to be generally narrower than that. They render necessary low dams, long races, and in some cases low dikes to prevent overflow; even then the meadows are at times submerged.

a Also often written *Hoosick*.
b *Historical and Statistical Gazetteer of New York.*

The Hoosac has a large fall, but elevations which should show the true amount could not be obtained, except for one or two very limited sections. A large share of the fall has already been improved, and splendid mills and factories are scattered all along the river's course. On the upper waters, in Massachusetts, the main branches of manufacturing are in prints, cotton-warps, ginghams, and woolen goods. The productions by water-power along the river also include some other varieties of cotton goods than those above mentioned, as well as twines, knit goods, paper, mowing- and reaping-machines, axes, powder, and flour; some of the works, notably those at Hoosac Falls, being of unusually large size. Notwithstanding the number of mills already erected, there is some available fall still undeveloped between Williamstown and Hoosac Falls, while at Schaghticoke, but a few miles from the mouth, far the greatest concentrated power on the entire river remains only slightly improved. The Troy and Boston, and the Boston, Hoosac Tunnel, and Western railroads both follow the course of the river closely from Schaghticoke village to North Adams, and are intersected at several points by north-and-south lines.

During the summer of 1880, which was a year of very small rainfall in this section, the flow of the Hoosac at Schaghticoke was carefully observed under the direction of Mr. Leonard M. Wright, civil engineer, of Troy, who has kindly furnished the results of his examinations. In the latter part of May he computed the flow by taking a cross-section and the velocity of the current, and thus found the volume to be 455 cubic feet per second at what was termed the "ordinary stage" of river. The result was closely verified by a weir measurement on the Schaghticoke Powder Company's upper dam. From May 29 to July 31 the depth on the crest of this dam at 6 a. m., 12 m., and 6 p. m. was recorded daily. The approximate discharge as thus indicated, for the entire period of nine weeks, appears to have been an average of between 350 and 400 cubic feet per second, and the minumum for any one day (average of the 24 hours) about 185 cubic feet per second. This result is at variance with the minimum flow differently estimated by Mr. Wright by computing the amount of water used in the water-wheels at this dam, and by which method he makes the minimum flow about 300 cubic feet per second. The drainage area above Schaghticoke being 625 square miles, a discharge of 185 cubic feet corresponds to about 0.30 cubic foot per second per square mile. The river is subject to heavy ice runs, and is considered to rise and fall quickly after storms. There is but a moderate amount of storage in reservoirs, and that is at the extreme head-waters. The pondage by the dams along the stream is not usually large, and the steep impervious slopes which characterize much of the drainage basin favor the rapid carrying off of storm-waters, from which causes it would be reasonable to expect considerable fluctuations between low and high water.

In ascending the river, water-privileges are met as follows:

Power at Schaghticoke.—The village of Schaghticoke, sometimes called Hart's Falls, has a population of 1,300, is the site of several important manufacturing concerns, and by the large unimproved water-power which it possesses offers facilities for a much farther increase in such industries. It has good railroad connections in all directions, is distant about a dozen miles from Troy, and half that number from Mechanicsville, on the Hudson, where, as we have seen, a fine power has recently been developed for the manufacture of paper and pulp. At this locality the banks of the Hoosac are high and rocky, and the bed is composed of slate ledges dipping to the eastward at a large angle. The width varies, but at the road bridge is about 350 feet between banks. Beginning at the Cable Flax Mills' upper privilege five distinct falls may be recognized directly in the village, three of them more or less used for power at present, and two entirely unoccupied. The total descent on the five falls is about 97½ feet. The mills are all on the right bank, on which side the village is mainly situated, and toward which the natural tendency of the current carries the major portion of the flow.

The upper privilege is improved by a timber dam extending clear across the river, and embraces a fall of 8 feet. Power is used by Wiley & Button, manufacturers of straw wrapping-paper, and by the Cable Flax Mills Company in its No. 3 mill. This company manufactures twines, yarns, shoe-threads, and similar goods, and uses here a single wheel of 60 horse-power. The paper-mill wheels are of old style and their power was not accurately known. At the time Mr. Wright, acting for the owner of the large water-power at Schaghticoke, measured the flow of the stream he also prepared a statement showing the gross or theoretical horse-power that had been sold from each fall. From this it appears that, in the summer of 1880, 121 gross horse-power had been disposed of to manufacturers at the upper fall. Wiley & Button say that there is sometimes a lack of water for their wheels. Two or three winters ago the stream froze very thick and they were short of power for two months.

The second fall is 7½ feet, and is partially improved by a log dam running from the right bank about half-way across to an island. The power here is used by the Cable Flax Mills Company, which has 250 horse-power of wheels, but is short of water for running at full capacity about four months in the year. The privileges here described succeed one another closely, the descent of the stream being very rapid.

The third to be noticed has a total fall of 24½ feet, included in which is a sudden pitch of 12 or 15 feet over a slate ledge. Just above this pitch are the partial remains of an old dam by which the privilege was formerly improved. There were mills at each end of the dam, but they were burned and only a few ruins are left. The site is a fine one, but is reported to have been held at a very high price, which has prevented its development.

The fourth power is the last one in order that is in use on the stream, and includes a fall of 34½ feet. It is occupied on the right bank by the Schaghticoke Woolen Mill, manufacturing fancy cassimeres and worsteds and having 12 sets of machinery. The head actually used here is 30 feet, under which is run one wheel of 170 horse-power.

There is always enough water, and for ten months in the year a waste day and night over the dam. The latter is a log structure, extending from the right or north bank diagonally up stream, and decreasing in height from about 9 feet till, as the river-bed rises sufficiently, it runs out on the rocks at the foot of an island. The entire river is not controlled; but, the island stretching up stream and the main channel setting toward the dam, the larger share of the water is diverted to the mill, which is located directly opposite the dam. The main building is of brick, 180 by 84 feet in plan, 4 stories high, with a large wing of 160 by 50 feet. Employment is given to 220 hands. Immediately below the woolen-mill is a 3-run grist-mill, receiving water from above the same dam through a distinct flume, and using the full fall of 34 feet.

The fifth and last of this series of falls includes 23 feet and is entirely undeveloped. It extends from the woolen mill privilege in heavy rapids down to what is known as the "big eddy", at no great distance below.

The power available at these falls may be estimated as follows:

Estimate of power at Schaghticoke village.

Stage of river.	RAINFALL ON BASIN.					Drainage area.	Flow per second, average for the 24 hours.	THEORETICAL HORSE-POWER.						
	Spring.	Summer.	Autumn.	Winter.	Year.			1 foot fall.	Upper fall, 8 feet.	Second fall, 7½ feet.	Third fall, 24½ feet.	Fourth fall, 34½ feet.	Fifth fall. 23 feet.	Total fall, 97½ feet.
	Ins.	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Sq. miles.*	*Cubic feet.*							
Low water, dry year	9	12	9½	7½	38	625	200	22.72	180	170	560	780	520	2,210
Low water, average year							250	28.40	230	210	700	980	650	2,770
Available 10 months, average year							360	40.90	330	310	1,000	1,410	940	3,990

NOTE.—The effective horse-power utilized can not be stated here with accuracy, but in the fall of 1882 there appeared to be in use an aggregate of about 600 horse-power of wheels.

Passing below the "big eddy" the river enters a narrow gorge, and for half or three-quarters of a mile runs with rapid descent between high and abrupt rocky banks. The bed is also rocky. For much of this distance the banks are too steep for the convenient location of mills, but the stream makes some very sinuous curves, and where it approaches the Boston, Hoosac Tunnel, and Western railroad there is an extensive open site having a gentle slope. A little way above this point an attempt was made years ago to utilize power for milling. A brush dam was built, and a race run diagonally across a bend behind a rocky bluff. The dam was carried away, but the canal remains, and an opportunity is presented for developing a good power, though the location has the disadvantage of being much below the grade of the railroad and away from the village, there being no settlement in the immediate vicinity. At the entrance to the old race the river-bed is of rock; the banks are of the same character and high on each side. The race itself is about 25 feet wide, excavated through rock part of the way, and is rather shallow, the bank on one side frequently being but 2 or 3 feet high; it is perhaps 600 or 800 feet long. From the bed of the race, between the old bulkhead walls at its terminus, down to the low-water surface of the river, 100 feet or so distant, the fall is 21 feet, which would be increased 2 or 3 feet from the water-surface in the race. The power corresponding to this fall may be judged by comparison with the estimate above, the volume of the river being practically the same as at Schaghticoke. Below the gorge the river finally issues among wide meadows, and thence to the mouth has but little fall.

As nearly as could be ascertained, the privileges here described were owned substantially as follows in November, 1882: Passing up through the gorge below the village, the estate of George M. Tibbits, (*a*) of Troy, includes all the land on the left bank (left descending) for 1 mile, more or less, nearly up to the woolen-mill fall. On the opposite bank John Downs, of Schaghticoke, owns up to the point where Betsy A. Hart's interest (*b*) begins. Above these proprietors Betsy A. Hart owns continuously on both banks up to the head of the falls, excepting certain limited powers disposed of to the different manufacturers.

The river above Schaghticoke.—A short distance up from the village the Schaghticoke Powder Company has quite extensive works on the south bank of the stream, and owns a total of 20 feet fall in two privileges. The dams are both timber structures, and rest on the solid rock which still constitutes the river-bed. The lower dam is 176 feet long, and varies in height from 18 inches to 10 feet, according to the profile of the rock on which it is built. A glazing-house and two packing-houses are supplied from this privilege, about 50 horse-power being in use. Water is carried from the dam a total distance of 790 feet, in a trunk which decreases from 4½ to 3 feet in diameter, giving a head ranging from 6½ to 12 feet.

The upper dam has a roll-way 244 feet long, with a quite uniform height of about 6½ feet. The wheels on this privilege run under 8 feet head and furnish in the aggregate 158 horse-power. Water is conveyed from the dam 950 feet, part of the way in an open flume 6 feet square, and the remaining distance in an underground trunk ranging in diameter from 4 to 3 feet. Power is furnished to two wheel-mills, a pulverizing-mill, a press-mill, and a corning-mill.

a Represented in Troy by Benjamin Hall, esq.

b Represented in Troy by William H. Doughty, esq.

The powder-mill dam sets the river back from half a mile to a mile, succeeding which is the power at Valley Falls. The dam at that point is built of squared timbers, the face having a small batter. It is 12 or 13 feet high, with top rafters 24 feet long, and is pinned to the bed-rock; it was built in 1881 to replace an old structure, and cost about $4,500. The head obtained at the mills is 15 or 16 feet. On the north side the power is owned and utilized by the Valley Falls Paper Manufacturing Company, manufacturer of straw wrapping-paper. On the south side power is used by the Valley Falls Knitting Mills, Harrington & Crapo's 5-run custom and merchant mill, and James Thompson & Co.'s mill for the manufacture of linen twines and yarns, cotton mosquito-netting, and buckram. The last-mentioned concern has 15 feet fall, 300 horse-power of wheels, and is usually short of water about one month in the year.

Slack-water extends 1 or 2 miles above Valley Falls, and thence to Johnsonville there are occasional riffles, but it is not considered that there is sufficient fall to constitute another privilege of any importance.

The next power is principally owned by the Johnsonville Ax Company, that concern being responsible for five-sixths of the repairs on the dam. The remaining share is in some dispute, but 1,000-spindle power is certainly reserved to J. H. Aiken, who runs a small grist-mill and cider-mill. The Johnsonville company is a large manufacturer of axes, of which it turns out from 10,000 to 12,000 dozens per year, and of various other tools such as hatchets and adzes, the production of which is about the same in number as of axes. This company has 4 water-wheels running under a head of 8 feet, and besides its tool-works carries on a small grist-mill. The dam is a log structure 450 feet long and ranging from 3 to 8 feet in height. It rests on rock throughout, was built some twenty-five years ago, and was largely repaired about 1880 or 1881. Although it forms a pond nearly a mile long, this is insufficient fully to store the night-water, even in the very lowest stage of river. In the dry season the ax factory is occasionally a little short of water, and in winter there is sometimes a short stoppage on account of anchor-ice. The extreme freshet-depth on the dam is stated to be probably not over 3 or 4 feet.

Ascending the stream toward Eagle Bridge the course is found to lie through meadows, and there is a fair current, but only moderate fall. The valley is open, with long, partially-wooded side slopes. At Eagle Bridge the main river is 130 feet wide, and a short distance above the crossing displays rock in one bank, while below are short rapids over a gravelly bed; the left bank is well suited to canal and buildings. The Owl kill comes in at Eagle Bridge, and in the lower part of the village of Hoosac Falls the main river is joined from the east by the Walloomsac, an important tributary and presenting near its mouth a fine unoccupied site, formerly utilized by a mill, which was burned.

The next improved power to be noticed on the Hoosac river is at Hoosac Falls, and is utilized by the very extensive works of the W. A. Woods Mowing & Reaping Machine Company. The manufacturing works, exclusive of the lumber-yard, occupy a wedge-shaped plot of ground three-quarters of a mile long, and a quarter of a mile wide at the base. The company employs 1,600 hands, and in 1881 turned out 46,000 machines. The river here descends over massive rock ledges, and at the top of the falls there is a low horseshoe-dam, part log and part framed. One water-wheel is used, rated at 300 horse-power, and run under a fall of 19 feet. There is at times a shortage of water in summer and steam has to be used. Trouble is also sometimes experienced in winter; the pond above the dam is shallow, and in extremely cold seasons freezes almost solid.

The next power is at North Pownal, Vermont, and is utilized by the fine mill of the North Pownal Manufacturing Company, running 50,000 spindles and 400 looms on print-cloths. The dam is a log affair, said to be a hundred years old; it measures 140 feet in length, and 22 feet in height from the foundation. Water is carried 125 feet to the mill through two 8-foot trunks, and used under a head of 17 feet. There are three water-wheels, each of 165 horse-power; only two are ordinarily used, the third being reserved for high water, when the head is reduced. For about nine months in the year these wheels can be run at full capacity, and in November, 1882, were being run at about one-half capacity, the stream being at that time very low. In September of the same year a new bulkhead was being put in at the dam, when a sudden and violent freshet destroyed the temporary works and carried away 30 feet of the mill.

From Hoosac Falls to Pownal, and above to Williamstown, an entire distance of about 15 miles, the fall of the stream does not appear to be fully taken up, and there is thought to be some further opportunity for manufacturing. The stream is in this section generally bordered by meadows, and is a succession of pools or stretches of smooth water separated by riffles over gravel shoals.

Above North Pownal the first use of power is by the Hoosac Valley Knitting Company, at South Pownal. One wheel, of probably 50 or 60 horse-power, is run under a fall of 9 feet. Two thousand spindles are operated in the manufacture of hosiery, shirts, and drawers.

At Williamstown, Massachusetts, the Hoosac is from 90 to 100 feet wide, and is utilized by the Williamstown Manufacturing Company, running 17,000 spindles and 378 looms on print-cloths. This company has 14 feet fall and 472 horse-power of wheels, which, as was stated, it had been able to run continuously from December, 1881, to July, 1882. The dam is in two sections, running to an island, and is in part framed and in part built of logs. Water is conveyed to the mill in a race several hundred feet long. The mill-ponds on this portion of the stream are usually small; that at Williamstown, the mill superintendent stated, could probably be drawn down by the wheels in three hours if not supplied from the stream.

378

The next manufacturing village is Blackinton, where the South Blackinton Woolen Company uses 12 feet of fall and runs 18 sets of machinery on fancy cassimeres. The company has one 54- and one 60-inch American turbine, which can be run at full power about three months in the year. The dam is a log and stone crib-work built on a rock foundation. Both head- and tail-race are long, and the former troubles seriously at times in winter by freezing solid. Much difficulty is also experienced with anchor-ice.

The Greylock Mills are next in order, with 6,800 spindles and 300 looms for the manufacture of fine ginghams. The dam is of stone in cement, 210 feet long. A 5-foot Swain and a 4-foot Hunt wheel are run under a fall of 17 or 18 feet. The supply of water is sufficient for full power about half of the year, but the remainder of the time steam is used as auxiliary.

The last power on the main river is at the village of Braytonville, in the town of North Adams, and is occupied by the North Adams Manufacturing Company, running 12 sets of cards on fancy cassimeres. The dam is about 190 feet long and 12 feet high. Here, as has been noticed farther down its course, the stream is bordered by meadows and long races are necessary. At this privilege the head-race is from three-eighths of a mile to a half-mile long and the tail-race is about a quarter of a mile long. A fall of 20 feet and 125 horse-power are in use. This amount of power is stated to be obtained about eight months in the year, but at times in the dry season the amount falls as low as 40 or 50 horse-power for several days in succession.

Summary of the principal water-privileges on the Hoosac river below North Adams (in order passing down stream).

Locality.	Firm.	Manufacture.	Fall.	Horse-power of wheels in use.	Remarks.
			Feet.		
Braytonville	North Adams Manufacturing Company.	Fancy cassimeres	20	125	12 sets of cards. Can run full capacity by water-power eight months in the year.
Greylock	Greylock Mills	Fine ginghams	17–18	325	300 looms; 6,800 spindles. Use steam as auxiliary power half the year.
Blackinton	South Blackinton Woolen Company.	Fancy cassimeres	12	180	18 sets of cards. Runs at full capacity by water-power three months in the year.
Williamstown	Williamstown Manufacturing Company.	Print-cloths	14	472	17,000 spindles; 378 looms. Pond alone would carry mill not over three hours. Uses steam a large part of the year.
South Pownal	Hoosac Valley Knitting Company.	Hosiery, shirts, and drawers.	9	50–60	Runs 2,000 spindles.
North Pownal	North Pownal Manufacturing Company.	Print-cloths	17	330	Extra wheel of 165 horse-power is used in high water. Company runs 50,000 spindles and 400 looms.
Hoosac Falls	W. A. Woods Mowing & Reaping Machine Company.	Mowers, reapers, etc.	19	300	Very extensive works. Employs 1,600 hands, and turned out 46,000 machines in 1881.
Johnsonville	Johnsonville Ax Company	Axes, hatchets, adzes, and other tools; also runs a small grist-mill.	8	200±	Manufactures 10,000–12,000 dozen axes per year, and an equal number of other tools.
Do	J. H. Aiken	Runs a small grist-mill and cider-mill.			Owns 1,000 spindle-power.
Valley Falls	Valley Falls Paper Manufacturing Company.	Straw wrapping-paper	15–16	540	Permanent power thoroughly utilized, and mills short of water in the dry season from a few days to a month or more.
Do	Valley Falls Knitting Mills	Knit underwear			
Do	Harrington & Crapo	Operate a 5-run custom and merchant mill.			
Do	James Thompson & Co	Linen twines and yarns, cotton mosquito-netting, and buckram.			
Shortly above Schaghticoke	Schaghticoke Powder Company	Powder	8	168	
Do	do	do	6½–12	50	
Schaghticoke	Wiley & Button	Straw wrapping-paper	8		Large proportion of power not utilized. See description of powers at Schaghticoke and below.
Do	Cable Flax Mills Company	Twines, yarns, shoe-threads, etc.			
Do	do	do	7½	600±	
Do	Unoccupied		24½		
Do	Schaghticoke Woolen Mill	Fancy cassimeres	30–34		
Do	D. Ewart	3-run grist-mill			
Do	Unoccupied		23		
Below Schaghticoke	do		23±		

At North Adams the main Hoosac divides into the North and South branches; each of these supports a large amount of manufacturing, and will be separately described.

The *North branch* at North Adams runs with rapid descent through a narrow and rugged valley. Its bed is of solid rock or is covered with gravel and bowlders, and it seldom exceeds 50 or 60 feet in width where running freely. On neither branch of the Hoosac are the dams an important feature, they being generally of moderate length and height, built variously as stone or timber structures. Aside from that contained in a small reservoir in the upper waters, the amount of water ponded is small, and it was stated that on the North branch probably no mill could be run more than 3 hours on its pondage alone. The chief dependence of the stream in the dry season is on the Clarksburg reservoir some 2½ miles above North Adams. It now flows 44 acres, and can be drawn down about 8 feet from full-water line. It is controlled by an association of the mill-owners, and for four weeks will keep up the supply needed at Briggs' mill, the uppermost in the village. It is practicable to enlarge this reservoir to 156

acres, with opportunity to draw it down 22 feet from full-water line, which would insure to Briggs' mill 80 horse-power, on a fall of about 27 feet, for 100 days in the dry season. It is said that there are also other places on the upper waters of this branch where small reservoirs of from 25 to 50 acres could be constructed.

From the Clarksburg reservoir down to the crest of Briggs' dam there is stated to be 100 feet or more of fall, more or less completely taken up in several unimportant grist- and saw-mill powers. Thence to the mouth of this branch the privileges are, in order, as given below. The figures for fall are kindly furnished by Mr. Briggs, and were determined by careful leveling; in some cases there is a slight variation from figures given by the different mill superintendents, but it is not important, and is very likely accounted for by the use of flash-boards.

Water-privileges on the North branch of the Hoosac river, in North Adams (in order passing down stream).

Firm.	Manufacture.	Fall.	Horse-power of wheels.	Remarks.
		Ft. in.		
Briggs Brothers	Fancy cassimeres	27 4	125	8 sets of machinery; 140 hands. Production 30,000 yards per month. Can run at full capacity by water-power about 8 months in the year. Under ordinary circumstances the power would not fall below one-half capacity, even in a very low stage; but on account of the small pondage here, and the holding back of water at uncertain times by the mills above, the flow is very irregular, and the power sometimes runs as low as 15 or 20 horse-power.
Privilege owned by Gallup & Houghton	Unimproved	40 0±		
Gallup & Houghton (Beaver mill)	Print-cloths	25 8	206	152 hands; 10,000 spindles; 232 looms.
Glen Woolen Company	Fancy cassimeres	14 2	97	100 hands; 8 sets of machinery.
Arnold Print Works (Eclipse mill)	Prints	36 4	300	164 hands; 300 looms; 12,000 spindles. Have also a 300 horse-power engine. Can run by water-power alone four months in the year.
Do	Unused	20 0		
Freeman Manufacturing Company	Printing-works	11 7	60	
Freeman Manufacturing Company (Eagle mill)	Print-cloths	25 5	270	Steam used for auxiliary power from three to nine months in the year, according to the mill. At the three mills there are run, in the aggregate, 17,000 spindles and 295 looms.
Freeman Manufacturing Company (Estes mill)	do	15 5	60	
Freeman Manufacturing Company (Stone mill)	do	13 9	35	
R. L. Jones leases privilege from Arnold Print Works.	Satinet warps and cotton towelings.	9 5	55	Runs 1,100 spindles. Considers steam principal power.

The *South branch* runs with less rapid fall and through a more open valley than the North branch, and between North and South Adams is bordered by extensive meadows. It is supplied in the dry season from what is known as the Cheshire reservoir, lying in the town of that name. This is estimated to contain from 600 to 700 acres, and can be drawn down 7 or 8 feet from full-water line. It fills regularly in the spring, and is drawn upon for from five to eight months. The reservoir is controlled by an association of the mill-owners. The flowage could not be increased, it is said, without a large expense in raising the Pittsfield and North Adams railroad track, which is close at hand. The manufacturing on this branch is mainly at South Adams, and some data concerning the various privileges in use will be found in the accompanying table. Above Adams' mill, the uppermost mentioned, there is reported to be a tannery, in Cheshire, but probably no other powers are in use, at least none of importance. At South Adams all the principal mills rely upon steam more or less of the year for auxiliary power.

Principal water-privileges on the South branch of the Hoosac river (in order passing down stream).

Firm.	Manufacture.	Fall.	Horse-power of wheels.	Remarks.
South Adams and vicinity.		*Feet.*		
J. S. Adams	Cotton goods	16	110	Owns 32 feet of fall, but uses only 16. Runs 5,000 spindles.
H. S. Millard	do	19	75–80	5,200 spindles.
B. F. Phillips & Son	Fancy cassimeres and ladies' dress goods.	13	92	7 sets of machinery. Can run at full capacity by water-power not over eight months in the year.
Adams Brothers & Co	Cotton warps	16	80	3,000 spindles.
Renfrew Manufacturing Company	do	13	70	8,196 spindles.
Plunkett & Wheeler	Cotton warps	19–20	125±	3,500 spindles.
L. L. Brown Paper Company	First-class ledger papers	11½	100	The mills together produce 7,340 pounds of paper per day and give employment to about 175 hands. At the lower mill there are two wheels supplied from the same level, under 11 and 13 feet fall, respectively.
Do	do	11–13	144	
Renfrew Manufacturing Company		7		
W. C. Plunkett & Sons	Cotton warps	15	130±	2,500 spindles.
Renfrew Manufacturing Company	do	15	145	4,320 spindles.
Do	Ginghams	18	290	Can run wheels at full capacity not over two months in the year. Splendid mill, with 1,000 looms and 16,876 spindles.
Do	Cotton warps	8½	40–50	1,200 spindles.
North Adams.				
M. D. & A. W. Hodge	5-run grist-mill	10	60	
Johnson Manufacturing Company	Ginghams	16	195	300 looms; 9,000 spindles.

FISH CREEK.

The principal source of this stream is in Saratoga lake, whence it flows with an indirect easterly course, about 8½ miles in length, to the Hudson river, which it joins at Schuylerville. Through Kayaderosseras creek, the chief tributary of the lake, the drainage area of the main stream is extended over the whole of central Saratoga county, and at the junction with the Hudson includes 253 square miles. Though often described as of larger dimensions, Saratoga lake is represented on French's map of New York state as 1⅜ mile wide in the broadest part, and as having a length of 4¼ miles in the main portion, increased by a narrow arm to about 6½ miles; the area thus covered is 5.6 square miles. The country about the lake is flat or gently rolling, and toward the outlet is low and marshy. The uppermost dam on the outlet is at Grangerville, distant 4½ or 5 miles from the extreme terminus of the lake, and so far removed from the latter that it is said to have no influence, of importance at least, upon the storage. The lake rises in spring, and then gradually falls, through the natural drainage of the outlet, and at times there is scarcely any water running in Fish creek. The fall is slight in the latter till it reaches Victory Mills, a mile and a half or more from the mouth, but below that point there is quite a rapid descent, which is pretty thoroughly utilized for power. In this part of its course the banks are much of the way bold and steep, and both they and the bed are composed of slate and shale dipping to the southeast. In its lower course the creek averages from 60 to 75 feet in width. It carries some anchor-ice in winter, but seldom freezes over. The lake holds back freshet water, so that little inconvenience is occasioned from that source, but some trouble is at times suffered at the lowest privilege from backwater, due to freshets in the Hudson. In April, 1869, there is said to have been an unusually heavy freshet both in Fish creek and in the Hudson, the former rising above its banks at Schuylerville and well up into some of the mills.

The first privilege above the mouth is at the village of Schuylerville, and is owned by Messrs. D. A. Bullard & Sons, with the exception of a small power belonging to Craw & Dennis, utilized in a foundery and machine-shop. The dam is of stone in cement, from 130 to 140 feet long, with a vertical face from 7 to 9 feet high, the back slope being planked over; it rests upon rock, and presents an angle up stream. The race is open for 25 feet, and then passes underground the rest of the way to the mills. The fall obtained ranges, according to position on the race, from 14 to 18 or 20 feet. The principal use of power is by the Messrs. Bullard in the manufacture of writing- and printing-papers and card-board, their production amounting to 4 tons per day. Besides the works already noticed there are also operated on this privilege a 5-run grist-mill and a small sash and blind shop. Altogether about 370 horse-power of wheels is in use. For one or two months in the year there is a scarcity of water, but the paper-mill has steam for auxiliary power, and has never been forced to shut down from low water for more than a few hours at a time.

Close by, the Bullards own a privilege on the Champlain canal, utilized by a saw-mill, and which is of interest as having once been owned, and the saw-mill run, by General Schuyler, whose former residence is yet standing on the opposite bank of the creek.

Below the paper-mill tail-race there is a fall of about 3 feet to the Champlain canal aqueduct, which will be made available at the mill by dredging the channel. There is also said to be a further fall, in an ordinary stage, of some 4 feet down to the mouth of the creek.

Above the Bullard privilege the greater part of the land along the creek and all the utilized powers are owned by the Saratoga Victory Manufacturing Company. This company has two mills—the Horicon mill, at Schuylerville, with 10,060 spindles and 264 looms, and the Victory mill, about a mile above, with 29,000 spindles and 611 looms. The manufacture comprises silesias, cambrics, bleached goods, and wigans, and amounts to about 6,000,000 yards per year. Steam is used for auxiliary power, there being a greater or less shortage of water during three or four months of the year, and at times it is said that there is hardly enough water for turning the shafting in the mills. The Horicon privilege immediately succeeds that owned by the Bullards, and includes 24 feet fall. The dam is a straight timber structure resting upon and abutting against solid rock. It is 19 feet high, the face nearly vertical. The race leads underground perhaps 300 feet to the mill, where power is taken from a 160 horse-power wheel.

At Victory Mills the dam is also of timber, rests upon a ledge, and is about 140 feet long and 8 feet high. Water is conveyed in a race 500 feet, more or less, and operates an 800 horse-power Holyoke wheel, running under a head of 40 feet. Only about 600 horse-power, however, is actually in use. The wheel-pit is sunk 30 feet into solid rock. The tail-race extends thence 170 feet through a tunnel 13 feet wide and 7 feet high, and then 500 or 600 feet farther in an open channel.

Above Victory Mills the stream is quite flat, with no dam except at Grangerville, where about 14 feet fall is owned by the Victory company and utilized by a saw- and grist-mill. Both above and below Grangerville there are occasional rifts where the water is shallow; and in order to drain as thoroughly as possible the pools or deep stretches above them, the Victory company has run canals around the rifts, and by means of head-gates controls the flow.

THE BATTEN KILL.(a)

This is one of the best mill-streams tributary to the Hudson. Its sources are in the southwestern part of Vermont, in the towns of Peru, Dorset, and Winhall, Bennington county. At first the stream runs southwesterly,

a Kill (Dutch *kil*) is the equivalent for "river" or "stream".

but it then strikes more to the westward, and with a very irregular course crosses Washington county, New York, entering the Hudson a mile above Schuylerville. It has a length from source to mouth, by general course, of about 45 miles, and a drainage basin of 457 square miles. This basin lies on the western slopes of the Green mountains, and in Washington county is crossed by three minor ranges running northeast and southwest—the Cossayuna range, the most westerly, passing through the towns of Easton, Greenwich, and Argyle; while to the east are met, successively, continuations of the Petersburg mountains and Taghkanick range, of Rensselaer county. These ranges have steep slopes, are composed of slate rock, which frequently crops out and is largely quarried, and the disintegration of which has given the highlands a very fertile soil. In the eastern part of the county the highest summits reach altitudes of from 1,000 to 1,200 feet above tide. The agricultural productions of this section comprise rye, spring wheat, oats, buckwheat, corn, peas, beans, flax, and potatoes. Stock-raising, dairying, and wool-growing are prominent industries.

As might be expected from the nature of the country drained, the Batten kill is subject to quite heavy freshets and runs of ice, but its current is rapid and high water quickly subsides. It is very largely fed by springs, so that the dry-season flow is well sustained. It is a common opinion that the flow might still further be improved by storage reservoirs, to which the upper waters of the main river and its tributaries are thought to be favorable. In particular there are mentioned two large ponds the waters of which reach the river 1½ or 2 miles above Battenville through Cossayuna creek. The principal one of these is known as Cossayuna lake, and is nearly 3 miles long, and over half a mile wide in the broadest part. It lies on the boundary between Greenwich and Argyle towns, and above there is another of good size, called Gifford's pond, the two being connected on nearly or quite the same level. There is a small mill at the outlet of Cossayuna lake, and it is stated that the dam at that point can be raised several feet, thus giving a splendid storage above. The tributary drainage area at the outlet of Cossayuna lake is approximately 9 square miles, and the average annual rainfall on this area is about 38 inches.

The immediate course of the river is through a fertile and well-settled valley, with numerous small villages, of which the most important is Greenwich, having 1,200 inhabitants. Railroad facilities are somewhat deficient, the lines which reach this section running at right angles to the general course of the stream in its most important portion. The upper river, however, above the village of Arlington, Vermont, is followed to the head by the Bennington and Rutland railroad, and the Rutland branch of the Delaware and Hudson Canal Company's railroad follows the middle course for about 4 miles. From Greenwich, on the lower river, a short line runs southerly, connecting with the Hoosac Tunnel route for points east and west.

According to the Delaware and Hudson Canal Company's profiles, the water-surface of the river, at the crossing a little south of Shushan, is 432 feet above mean-tide at Albany, or about 437 feet above mean ocean-level. Judging from the best data to be obtained, the elevation at the mouth of the river may be placed at about 82 feet above mean ocean-level, though this amount is liable to be slightly in error. There is, then, a descent of about 355 feet in the intervening distance of 22 miles, or an average of say 16 feet per mile. Very nearly, and perhaps quite, one-half of this, however, is concentrated within the last 4 or 5 miles of the river's course, and since the volume is there the greatest the value of the Batten kill for power is greatly enhanced by the fact.

The first water-privilege met in ascending the stream is but a short distance above the mouth, at a place locally known as Clark's Mills. The river there runs between banks and over a bed of black slate rock, is about 250 feet wide, shallow, and contains rapids with moderate fall for 800 or 1,000 feet below the dam. The privilege is owned by Hiram Clark, and is utilized on the north bank in the manufacture of sashes, doors, and blinds, a saw-mill and plaster-mill also being run in connection with the other works. A log dam, 9 feet high, runs across to a ledge on the south bank. The fall obtained at the mills is 10 feet. There is at times a little scarcity of water, but it is due to the very leaky condition of the dam, and even in its present condition the proprietor counts upon 100 horse-power in the very lowest stage of the river. Once in three or four years some hinderance is experienced for perhaps a week, due to backwater from the Hudson. In the spring break-up gorges form at the head of the pond, and when they go out cause a very heavy run of ice.

Clark's pond sets back not over half a mile, and is succeeded by rapids on to the foot of the "Big falls". The immediate course of the stream is bordered by narrow meadows, from which there is a moderately steep rise of possibly 100 feet to the general level of the surrounding country, below which the valley is depressed. For a part, at least, of this intervening distance the adjacent land is included in the estate of Barant B. Lansing.

Next in order comes the power at the "Big falls", the Indian name of which was Dionondahowa. When visited, the privilege was being developed by its owner, Mr. W. N. Sprague, of Middle Falls, and a splendid power had easily and with remarkable cheapness been obtained. The locality is about 2½ miles by direct course from either Schuylerville or Greenwich. A bridge is contemplated near the dam, which will give a direct and convenient route to Schuylerville, and it is claimed that a railroad can, and probably will, be run here from Greenwich. At the former of these points the Champlain canal will be reached, and at either one connection can be obtained with the Boston, Hoosac Tunnel, and Western railroad. Below the head of the falls the stream rapidly cuts its way down into the slate rock, the strata of which are almost vertical, and forms a deep gorge with precipitous sides. It descends into a quiet pool, and then continues on through the gorge with moderate

fall. At the head of the falls, where the dam is located, the stream runs north, the west bank is high and rocky, while the east is gently sloping and succeeded by fine open ground, which also extends down some distance and affords good building-sites. The dam abuts at the west end against the rocky bank, and at the east end has a masonry abutment 14 feet long, from 4 to 6 feet wide, and rising 4 feet above the crest. In construction the dam is a log crib-work filled in with stone and pinned down to the solid ledge rock on which it is built. The roll way or overflow is 265 feet long, and ranges in height from 7 to 12 feet, according to the contour of the rock. It was built with 2½ base to 1 vertical, so that where of the full height of 12 feet the width at base is about 30 feet. The bulkhead is of timber, and has a length, transversely to the current, of 25 feet. From it a canal runs down the east bank, 2,800 feet long, 25 feet wide, and 7 or 8 feet deep. It is partly in rock excavation, and in its course enters a natural depression, where it is to be diked on either side.

The entire descent from the crest of the dam to the pool below the falls is 106 feet, which is to be used in five successive falls of 13, 18, 20, 25, and 30 feet, respectively. The Ondawa Paper Company has purchased the lower fall of 30 feet and erected a mill 210 by 60 feet in size, for the manufacture of manila paper, with a capacity of 4 tons per day. The mill has been built directly on the brink of the river-bank, which is here high and very steep. The entire 30 feet is used in one fall. Water enters two upright wooden pen-stocks, cylindrical in shape, measuring 9 feet in outside diameter. The bottoms are of oak and the sides of 3-inch chestnut. On the outside are hoops of round iron, increasing in diameter from three-quarters of an inch at the top of the cylinders to 1 inch at the bottom, and decreasing in distance apart similarly from 2 feet to 3 inches. The planks composing the sides are in four unequal lengths, breaking joints. In order to secure tight joints, the ends of the planks are sawed into, a little way, and pieces of hoop-iron inserted.

In November, 1882, the work on the race was well advanced. There was a small saw-mill at the dam, and that, with the paper-mill, were the only buildings which had been erected. Mr. Sprague owns 133 acres of land here, and is prepared to lease, or otherwise dispose of, to manufacturers, sites and power to the full capacity of the privilege, excepting, of course, the 30 feet fall already sold to the paper company.

Estimate of power available at the "Big falls" on the Batten kill.

Stage of river.	RAINFALL ON BASIN.					Drainage area.	Flow per second, average for the 24 hours.	THEORETICAL HORSE-POWER.							
	Spring.	Summer.	Autumn.	Winter.	Year.			1 foot fall. (a)	13 feet, upper fall, not used.	18 feet, second fall, not used.	20 feet, third fall, not used.	25 feet, fourth fall, not used.	30 feet, fifth fall, used.	76 feet, total fall not used.	106 feet, total fall on privilege.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. m.*	*Cu. ft.*								
Low water, dry year	9	11¼	9½	8	38	454	180	20.45	270	370	410	510	610	1,560	2,170
Low water, average year							200	22.72	300	410	450	570	680	1,730	2,410
Available 10 months, average year							280	31.81	410	570	640	800	950	2,420	3,370

a Mr. Sprague, the owner of the privilege, estimates 30 effective horse-power per foot of fall available twenty-four hours in the day, eleven months in the year, or twelve hours per day throughout the year.

From the privilege just described up to that at Middle Falls there is said to be about 10 feet of fall available for power, and owned by Messrs. David C. Fielding and Nathan Tefft.

At Middle Falls, a small village, the river again descends abruptly over ledges, and below winds through extensive meadows. Just above the dam the width between banks is about 175 feet. The dam itself is at the head of the falls and measures 135 feet between abutments, and varies from 12 to 16 feet in height above foundation; it is built as a log crib-work.

The total fall on this privilege is 47 feet. Mr. W. N. Sprague owns the power on the right bank, and employs it in the manufacture of wood-pulp and leather-board. The water is used in two successive falls, being first carried 80 feet from the dam and used under a head of 20 feet, running three wheels of 250 aggregate horse-power. It is then carried 60 feet farther, and runs a 150 horse-power wheel, acting under a head of 27 feet. It is designed so to enlarge the works as to employ the full power of this second fall. During the very dry summer and fall of 1882, all the wheels mentioned could be run at full capacity twelve hours per day, and twenty-four hours per day except on eleven days, when they were run varying periods between twelve and twenty-four hours. On the left bank Cipley & Hegeman have a 5-run flouring- and grist-mill, a plaster- and cement-mill, and a small saw-mill. They use a fall of 17 feet, and six wheels with a total of 135 horse-power. H. R. Richardson rents 200 square inches of water under 12 feet head. He has an old 30-inch Rich wheel of perhaps 30 horse-power, and manufactures cattle-hair horse and army blankets, turning out about 6,000 pounds per month.

Estimate of power at Middle Falls.

Stage of river.	Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		Effective horse-power of wheels in use.
	Sq. miles.	*Cubic feet.*	*1 foot fall.*	*47 feet fall.*	
Low water, dry year	450	180	20.45	960	500–600
Low water, average year		200	22.72	1,070	
Available 10 months, average year		280	31.81	1,500	

The Middle Falls dam sets back the river for about a mile and a quarter; thence to the lower dam at Greenwich there are occasional riffles, but no fall occurs of any consequence. In the vicinity of Greenwich the surrounding country is to a large extent very flat, though in places diversified by hills. The village is a fine and important one, and within its limits the Batten kill sustains quite a manufacturing interest, being utilized in three falls.

The first privilege met in ascending is occupied by Dunbar, McMaster, & Co., a branch house, of which the main establishment is at Guilford, Ireland, and the mills are known as the Dunbarton Flax Mills. The production comprises linen threads, yarns, and fine twines, and amounts to nearly a ton per day. The flax used is mostly imported, but 200,000 pounds per year of the American material are also worked up. A great deal of flax is raised in this part of New York state, notably in Washington and Rensselaer counties. The dam at this privilege is a log and stone crib-work, probably 200 feet long and about 8 feet high. There is a masonry abutment at the north end, from which it runs diagonally across the stream to a rock ledge. It has a sloping timber apron, 25 feet wide half-way across and about half that width the rest of the distance. A covered timber flume, 5 by 12 feet in inside dimensions, conveys water to the wheel, which is rated at about 130 horse-power and runs under a head of 11½ feet. The water-power is, for some reason, not fully utilized here, even in the lowest stage, and steam is constantly used in part for power. The ordinary freshet depth on the dam is stated as not far from 3 feet. Some trouble is experienced from backwater due to freshets, which have at times set up into the dye-house of the mill; and also from that due to ice-gorges in the river below, by which a day's stoppage is sometimes forced.

The next privilege quickly succeeds, and is improved by a framed dam built on a rock ledge. This dam is 200 feet or more in length, about 9 feet high, and was built 10 or 12 years ago at an estimated cost of $4,000. The top, for 40 inches back from the crest, is shod with ¼-inch boiler-iron. On the north or right bank, two-thirds of the entire flow of the river, less 228 square inches reserved, is owned by W. M. Palmer, and used in part for a 6 run grist-mill and a small saw-mill under a fall of 10 feet. The 228 square inches, under a fall of 10 feet, is stated to be owned by Gray & Mowry, who rent the power for a small batting-mill. On the south bank the remaining one-third of the power is owned by W. Eddy & Sons. A 100 horse-power wheel, under a fall of 12 feet, supplies power for dressing flax and for a small shirt factory.

The upper privilege is improved by a framed dam some twenty years old; this is 5 or 6 feet high, rests upon a rock ledge, and has masonry abutments. Water is admitted through a wooden bulkhead with four gates to the race, and passes thence a short distance to the mills. The privilege is owned by Messrs. Jesse V. & William B. Palmer, who use part of the power in the manufacture of knit underwear; 1,040 spindles are run by a 70 horse-power wheel operating under a fall of 7½ feet. Angell & Safford rent 800 square inches of water from the Palmers for the manufacture of brown hanging-papers, of which their production is 3,200 pounds per day. They have 7½ feet of fall and a 60 horse-power wheel.

Above Greenwich village there are occasional riffles up to Center Falls. There the river descends over ledges, falling about 25 feet in 700 or 800 feet. The banks are rocky and rise from 15 to 40 feet above the stream. The exposed rock is a slate, dipping about 45 degrees to the westward. At the head of the falls are the partial remains of an old log dam, from which water was formerly carried down the right bank in a race and used at mills that were afterward burned. The privilege is a fine one, 2 or 2½ miles above Greenwich, and is said to be owned by Mr. Daniel A. Bullard, of Schuylerville. The fall to be obtained depends upon the height of the dam, but probably there would be no difficulty in realizing 30 feet.

Estimate of power at Center Falls.

Stage of river.	Rainfall on basin.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		
	Spring.	Summer.	Autumn.	Winter.	Year.					
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	*1 foot fall.*	*25 feet fall.*	*30 feet fall.*
Low water, dry year	9	11½	9½	8	38	418	160	18.18	450	550
Low water, average year							180	20.45	510	610
Available 10 months, average year							260	29.54	740	890

At Battenville, 1¾ mile above, there is a very old log dam, ponding the water for about a mile up stream. It rests partly on rock, partly on quicksand, and is irregular in shape, with a sloping plank apron and a supplementary embankment at each end. The fall on the privilege is 9 feet. The available supply of water is put nominally at 1,400 square inches, of which one-sixth is owned by W. D. McLean, one-third by Nicholas Miller, and one-half by Mowry & Hobbie, who use the power, respectively, for a saw-mill, a 4-run grist-mill, and a straw wrapping-paper mill with a production of 2½ tons per day.

A mile and a half above Battenville, Cossayuna creek joins the main stream from the north. From Center Falls to Battenville the immediate valley is rather narrow, but thence up to East Greenwich, about 3 miles, the hills recede and the stream is bordered by meadows, which are much of the way very extensive. At East Greenwich the Batten kill is from 70 to 80 feet wide. The dam at that place is an old structure, about 210 feet long and 7 feet high, resting part of the way on rock and the remainder on loam and clay. The head realized is 7 or 7½ feet. On the south bank W. & A. Walker employ 20 hands and a 40 horse-power wheel in the manufacture of army blankets, and a small power is also used in a sash and blind shop. On the north bank there are a saw-mill and a 4-run grist-mill.

Just above East Greenwich, Black creek, quite an important tributary, empties from the north. The next use of power is at Baxterville, where the Vermont Marble Company employs 7 feet fall in sawing marble, which is brought there 55 miles by rail from West Rutland. An average of 75 saws is run, and about 30,000 cubic feet of marble are annually sawed. The dam is a log and stone crib-work, with a sloping apron, is 7 feet high and perhaps 150 feet long. The pond is said to extend about a mile up stream.

At Shushan, about 21 miles by river from the mouth, there is a log and stone crib-work dam, which was partially carried away some 15 years ago, and which affords a head of 7 feet. The establishments using power are small, and comprise a foundery, a saw-mill, a 5-run grist-mill, a 1-set woolen-mill for the manufacture of cassimeres and flannels, and a shirt factory. In low stages the supply of water is insufficient for the needs of these works, although the night-flow of the stream can then be ponded.

Above Shushan the Batten kill is described as having only moderate fall, and as running for a considerable distance through meadows, which it overflows in freshets. Powers are said to be in use all the way up toward the head, but they are of small size. Quite a large amount of timber used to be floated down the stream, and some is still driven to the mills which have been noticed, mainly spruce and hemlock. The drainage area above Shushan is 240 square miles.

Summary of the principal water-privileges on the Batten kill below Shushan.

Locality.	Approximate distance from mouth.(a)	Drainage area.	Manufacture, or kind of mill.	Fall.	Theoretical horse-power.			Horse-power of wheels in use.	Remarks.
					Low water, dry year.	Low water, average year.	Available 10 months, average year.		
	Miles.	*Sq. miles.*		*Feet.*					
Shushan	21	240	Foundery, saw-mill, 5-run grist-mill, 1-set woolen mill, and shirt factory.	7	.....	.....	.....	120	Shortage of water in low stages, though the night-flow can then be ponded.
Baxterville	.....	.....	Power used by the Vermont Marble Company for sawing marble.	7	.....	.....	.....	24	75 saws run, and about 30,000 cubic feet of marble sawed yearly.
East Greenwich	13½	389	Power used in saw-mill, grist-mill, sash and blind shop, and in the manufacture of army blankets.	7–7½	.....	.....	.....	(?)	20 hands employed in the blanket-mill.
Battenville	11	410	Power used in saw-mill, grist-mill, and paper-mill.	9	.....	.....	.....	175±	The paper-mill manufactures straw wrapping-paper; production, 2½ tons per day.
Center Falls	9	418	Not utilized	30±	550±	610±	890±	.....	Fine privilege; natural fall of 25 feet in 700 or 800 feet; rocky bed and banks.
Greenwich	6½	438	Knit underwear and hanging-paper.	7½	.....	.....	.....	130	1,040 spindles in knitting-mill. Production of paper-mill, 3,200 pounds per day.
Do	.....	.....	Power used in grist mill, saw-mill, batting-mill, shirt factory, and for dressing flax.	10-12	.....	.....	.....	(?)	Dam 200 feet or more long, 9 feet high, built 10 or 12 years ago, and cost say $4,000.
Do	.....	.....	Linen threads, yarns, and twines	11½	.....	.....	.....	130	Production nearly a ton per day.
Middle Falls	4	450	Wood-pulp, leather-board, and cattle-hair blankets; power also used in saw-mill, plaster- and cement-mill, and flour- and grist-mill.	47	960	1,070	1,500	500–600	
From Middle Falls to the Big falls.	.....	.....	Not utilized	10±	200±	230±	320±	.....	Said to be owned by D. C. Fielding and Nathan Tefft.
Big falls	2	454	Recently developed, and but partially utilized as yet.	106	2,170	2,410	3,370	.....	See description.
From the Big falls to Clark's Mills.	.....	.....	Not utilized	(b)	c 20.45	c 22.72	c 31.81	.....	
Clark's Mills	½	.....	Power used in sash-, door-, and blind-shop, saw- and plaster-mill.	10	.....	.....	.....	(?)	Occasional trouble from Hudson river backwater and from ice-gorges.

a By river. *b* Moderate amount. *c* Per foot of fall.

THE SACONDAGA RIVER.

This river, which ranks second below the Mohawk among the tributaries of the Hudson, in extent of area drained, is made up by three principal branches, which unite in the southeastern part of Hamilton county. The East branch has its source in the town of Johnsburg, Warren county, whence it runs to the southwest; the Middle branch receives the waters of Round lake and lake Pleasant, and then takes a curving course, about 10 miles in length, to the East branch; the West branch flows easterly from Piseco lake, and joins the united waters of the other two branches in the southern part of the town of Wells. From this point the main river passes to the southeast through about 16 miles of general course, crossing the adjacent corner of Fulton county, then turns suddenly to the northeastward into Saratoga county, and gradually curving around to the eastward empties into the Hudson at the village of Hadley. In the abrupt change of course which this river makes on the border between Fulton and Saratoga counties it presents a remarkable similarity to the upper Hudson, which has a corresponding sharp bend 18 or 20 miles to the eastward. From the mouth of the West branch the distance by river to the Hudson is by map measurement 40 miles.

The water-shed lines of the Sacondaga embrace an area of 1,028 square miles, nearly all of which is a mountainous country, traversed by various minor ranges which go to make up a part of the elevated Adirondack region of northern New York. The rocks are of primitive formation, and consist largely of gneiss. The soil is a light sandy loam, and elsewhere than in the valleys apparently has little value for agriculture. The entire district was once heavily clothed with timber, the most accessible portions of which have now been cut away; and though the amount standing is still of much importance, and the Sacondaga is claimed to outrank the upper Hudson in the number of logs driven down its course, the lumbermen have been forced farther and farther into the mountains, until now their operations are mainly in the region about lake Piseco. Settlement is sparse throughout the basin of this river, and especially so above Fulton county. The most populous township along the whole stream, Northampton, has but 2,100 inhabitants, and the largest village, Northville, 800. To this latter point a railroad extends from Fonda, on the line of the New York Central railroad, but nowhere else above its mouth is the stream directly accessible by rail.

From elevations (*a*) obtained in surveys by A. F. Edwards, chief engineer of the proposed Sackett's Harbor and Saratoga railroad, it appears that lake Pleasant has an altitude of 1,706, and Piseco lake of 1,648 feet above tide. Other elevations, from the same source, on the East branch and main Sacondaga are given in the following table:

Table showing the fall in the Sacondaga river.

Locality.	Approximate distance above mouth.	Elevation above tide.	Distance between points.	Fall between points.	Fall per mile between points.
	Miles.	*Feet.*	*Miles.*	*Feet.*	*Feet.*
East branch at Burnam's pond, Gilman	.....	1,706	.....	369	.....
East branch at head of High falls	.....	1,337	.....	132	.....
East branch at foot of High falls	.....	1,205	.....	163	.....
East branch at Copeland's mill-pond	.....	1,042	.....	84	.....
East branch at tannery mill-pond	.....	958	.....	56	.....
Main river at forks, Wells	40.0	902	5.2	139	26.7
Main river at Hope center	34.8	763	6.1	81	5.1
Main river at tannery, Northville	28.7	732	23.1	35	1.5
Main river at bridge, Huntsville	12.9	697	5.6	161	28.7
Main river above dam at Conklingville	5.6	697			
Main river at mouth	0.0	536			

So far as rapid fall and large volume are concerned, it is evident that the last 5 or 6 miles of the river's course, from Conklingville to the mouth, is the most valuable for power; in that distance there is a descent, as shown by the table, of 161 feet, which is accomplished quite uniformly, in rapids. About 39 feet of this fall is already utilized in three privileges, but the remainder is unimproved. Although it is, doubtless, perfectly practicable to develop nearly or quite all of the remaining fall, there are certain disadvantages to be encountered. In the first place, the composition of the river-bed and banks is variable, uncertain, and often unfavorable to the security of hydraulic works. For a mile above the mouth, the banks, while of good height, are largely composed of sand, with loose bowlders intermingled; and generally through the valley below Conklingville, so far as there was opportunity to examine, the surface materials in the vicinity of the stream were found to be very variable. The bed of the river is usually covered with gravel and bowlders, but instead of these being underlaid by solid rock, there is

386 *a* Quoted in F. N. Benedict's *Report on a Survey of the Waters of the Upper Hudson and Raquette Rivers.*

frequently found beneath a deep deposit of sand, with possibly some clay. Both the dams below Conklingville have been repeatedly carried out, and at the site of the lower one a hole 30 feet deep was in one instance scoured in the river bed. At the privilege occupied by the New York Pulp Company, perhaps 1½ mile or 2 miles from the mouth, clay is found in the tail-race, gravel and hard-pan occur near by in the bank, while bowlders, and gravel of all grades in fineness, form the surface of the river-bed, below which there is supposed to be mainly sand, a material that is also very common in the banks in that vicinity.

The Sacondaga contains a great deal of anchor-ice at the beginning of winter, and throughout the season if it be an open one, and is also visited by heavy ice-runs, although the cakes are commonly well broken up against the bridge-piers at Conklingville and in going over the successive dams there and below. Sudden and violent freshets occur, and considerable trouble is encountered from floating logs. These are not allowed to pass down when the stream is at its highest, as many of them would then be lodged upon the banks; but they are sent down when the river, though high, is well within its banks, and at the stage of water when they rake the dams the worst.

Assuming as correct the figures that have been given for the fall in the lower river, in the absence of any recorded gaugings the volume and corresponding power of that section may be estimated as below:

Estimated power of the Sacondaga river from the crest of the Conklingville dam to the mouth.

Stage of river.	RAINFALL ON BASIN.(a)					Drainage area.	Flow per second, average for the 24 hours.	THEORETICAL HORSE-POWER.			Approximate effective horse-power of wheels in use.
	Spring.	Summer.	Autumn.	Winter.	Year.			1 foot fall.	122 feet fall, remaining undeveloped.	161 feet fall, = total descent.	
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*				
Low water, dry year	9	12	11	8	40	b 1,016	90	10.22	1,250	1,650	Probably 600–800.
Low water, average year							120	13.63	1,660	2,190	
Available 10 months, average year						c 1,028	200	22.72	2,770	3,660	

a Roughly estimated; no data for accurate determination. b At Conklingville. c At mouth.

Excepting a limited use that is made of Piseco lake by the owners of the large saw-mills on the Hudson, the Sacondaga is not sustained in the dry season by any storage-reservoirs, though it can not be doubted that the many lakes within its basin present favorable opportunities for such improvements.

For three-quarters of a mile or a mile up from the Hudson there is a continuous rapid, with a fall estimated at 15 or 20 feet, which could be utilized near the mouth. We then come upon the privilege occupied by the Sacondaga Pulp Company, having a fall of 12 feet, the power being used for grinding poplar and spruce. The dam was built about the year 1876, and has been carried away in part two or three times since. It rests upon a sandy bed, is from 250 to 275 feet long, and has a sloping apron 30 feet wide, covered with round logs of small size laid with the slope. The structure is built of logs, filled in with stone part of the way across the stream, and is very leaky; it abuts against a ledge at one end, and next the mill against crib-work.

The second improved power closely succeeds the one just described, and is utilized by the New York Pulp Company, having 5 wheels, the combined rating of which was stated by the foreman of the mill as 425 horse-power. The dam is of logs, filled in with stone, and has twice been carried out. The first time it had merely been built up against the bulkhead without being bonded into it, and the adjacent portion was forced out. In order to pass the flow of the river while this first break was being repaired, a sluice was then cut near the center of the dam, reaching nearly to the base. There came a sudden rise in the stream, which brought down many logs; these crushed in the apron and injured the sluice; there was a heavy scour about the latter, and the section of dam farthest from the mill was swung around and carried down stream. At the time of the first failure the mill had been built out over the river and was also destroyed with the dam. It was afterward rebuilt in-shore. The present dam is 13 feet high, and with 2-foot flash-boards gives an available head of 15 feet at the mill.

From this point up there is a constant rapid, but there are no dams before reaching Conklingville, a small village between 5 and 6 miles from the mouth. The river-bed is there covered with bowlders and gravel, said to be underlaid by sand. The dam has stood some 50 years, is quite leaky, and has settled a foot or two. It has a sloping apron about 18 feet wide, and the whole is planked over; the structure is from 230 to 240 feet long, and has crib-work abutments with smooth timber facing. On the left bank a moderate power is used in Clement's woodenware factory, while on the right bank a race leads down several hundred feet to Henry Poor & Son's tannery, where a head of about 12 feet is obtained. In some years there is throughout a plenty of water at this privilege, while in others the supply falls short during August and September.

Above Conklingville smooth water is said to extend 20 miles up the stream, and the latter is navigated by a small steamer of 18 or 20 inches draught, used for towing scow-loads of hemlock bark. Above this flat stretch there are rapids again, and occasional powers are in use by saw-mills and tanneries. At Northville the Sacondaga has a tributary drainage area of 700 square miles.

THE SCHROON RIVER.

The extreme sources of this river are in the central part of Essex county, from 5 to 15 miles southeasterly from mount Marcy. It flows thence in a general southerly direction for about 45 miles and joins the Hudson nearly opposite Thurman station on the Adirondack railroad. In the middle part of its course, on the boundary between Essex and Warren counties, the river spreads out to form the extensive sheet of water known as Schroon lake, which is 8½ miles long and varies from half a mile to a mile and a half in width. Schroon river receives the drainage from an area of 556 square miles, almost entirely a rugged mountainous country traversed by numerous elevated ranges, once heavily clothed with forests, but now largely cleared; the soil is generally light, sandy, and poor, except in the valleys; the population is scattered, and above the mouth the river is nowhere directly accessible by railroad.

In Colvin's report on the *Survey of the Adirondack Region*, the elevation of Schroon lake is given as approximately 830 feet above sea-level; by the profile of the Adirondack railroad the corresponding altitude of the water-surface at the mouth of the river is 594 feet; from which it appears that, in the intervening distance of about 20 miles by general course, there is a fall of 236 feet.

Besides Schroon lake there are numerous other lakes and ponds within the basin of this river, most of which are said to be dammed and utilized for the operations of log-driving. Some data concerning these, contributed by Joel F. Potter, surveyor, to Benedict's report upon the upper Hudson, are given below:

Principal lakes and ponds in the Schroon River basin.

[From a report by J. F. Potter, in 1874.]

Name of lake or pond.	Surface in acres.	Remarks.
Schroon lake	4,730	There is a dam on the river, 5 miles below the outlet of the lake, which, if raised 2 feet, would flow several hundred acres above and around the head of the lake.
Paradox lake	1,520	Drains into Schroon river a mile north of the head of Schroon lake, and is on about the same level with the latter; by raising the dam, located 5 miles below the outlet of Schroon lake, 6 feet, Paradox lake would be raised at least 3 feet, and a body of water would be formed 24 miles in length, flowing, together with the lakes, 7,750 acres.
Brant lake	1,020	About 5 miles long; controlled by a dam.
Friend's lake	648	Controlled by a dam on the outlet.
Loon lake	400	It is estimated that by a dam on the outlet the capacity could be increased one-third.
Valentine pond	229	Lies in the town of Horicon, Warren county.
Lake Pharaoh	480	Raised 12 feet, and used for many years as a reservoir to supply water for driving logs.
Crane pond	338	Controlled by a dam which might be raised 20 feet.
Long pond	460	Drains to Paradox lake, and is controlled by a dam.
Mud, Clear, and Sand ponds	a 1,200	Lie at the head of the west branch of Schroon river, and are all controlled by dams for log-driving.
Bullpout pond	200	In the town of North Hudson, Essex county.
New pond	250	In Elizabethtown, Essex county.

a Combined area.

In considering the value of these lakes as reservoirs for storage, Mr. Benedict roughly estimates their aggregate capacity at about 5,900,000,000 cubic feet, which would insure a supply from this source of say 680 cubic feet of water per second for 100 days.

In proportion to its size the Schroon is a better stream for power than the upper Hudson. Its valley is more open and productive, better settled, and the stream itself more uniform in flow. It is comparatively well sustained in the dry season, is free from destructive freshets, carries but a moderate amount of anchor-ice, and surface-ice has very seldom been known to go out until it has first become thoroughly rotted in the ponds. The oscillations caused by rains are less rapid than in the Hudson, and it is said the latter will reach the top of a flood and begin falling before the Schroon has risen to its full height. The logging interest on the stream is still large, but an important part of the timber has been cut away, and operations are now confined to the region around and above Schroon lake.

Ascending from the mouth of the river after leaving the immediate valley of the Hudson, the Schroon becomes shallow and rapid. Gravel and small bowlders cover the bed, while the banks are of good height, and from the mouth to Warrensburg are generally gravelly or sandy in appearance. It is stated, however, that though the exterior is sandy, the banks are at a depth of a few feet composed of hard-pan. There is probably sufficient fall for one mill-privilege below Burnham's, the lowest now in use, and there is said to have been a dam many years ago at some point along this portion of the stream.

A mile and a half above the mouth and 2 miles below Warrensburg a fall of 12 feet is used by J. H. Burnham, who grinds and sells wood-pulp manufactured mainly from poplar. The dam is a log structure built about 1877. It is 100 feet long between abutments, 10 feet high, and probably 60 feet wide at the base. Of this width 27 feet is taken up by a sloping apron covered with round timber, and supported by four crib-work piers, each 12 feet square.

The proprietor claims that his dam could be raised 10 feet without overflowing the banks above to any important extent. Two wheels are in use of 75 horse-power each. For two or three months in the year there is some scarcity of water, but one wheel can always be run twenty-four hours in the day.

The next improved power is in the lower part of the village of Warrensburg, the principal settlement on the river. The Warrensburg Woolen Company owns and holds for sale the property on the right bank, where it formerly had a woolen-mill which was burned. The old dam stood a short distance below the present one, but, the bank at one end being sandy, water worked around the dam and carried it out. The present structure is a rough affair, perhaps 100 feet in length, with a long wing extending down to the mills and forming one side of the race. The establishments are small, and comprise a planing- and saw-mill, a sash-, door-, and blind-factory, and a shoe-peg factory. They are located on the left bank, use a fall of 10 feet, and have water-wheels with an aggregate rating of about 135 horse-power. For two or three weeks every year the supply of water is insufficient to meet the needs of these concerns.

Estimate of power at the lower water-privilege in the village of Warrensburg.

Stage of river.	RAINFALL ON BASIN.(a)					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		Effective horse-power utilized.
	Spring.	Summer.	Autumn.	Winter.	Year.					
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	1 *foot fall.*	10 *feet fall.*	
Low water, dry year	9	12	11	8	40	535	80	9.09	90	135±
Low water, average year							100	11.36	110	
Available 10 months, average year							150	17.04	170	

a Roughly estimated; no data for accurate determination.

The third dam on the Schroon is near the center of Warrensburg village, and is a log structure about 100 feet long. There is considerable fall below the dam, and the head obtained ranges from 4½ feet at the dam to 9 feet below. On the right bank B. P. Burhaus & Son use power in a saw-mill and a large tannery; they also have a 4-run grist-mill on the opposite side of the river. There are also located on this privilege A. C. Emerson & Co.'s saw-mill, sawing from 2,000,000 to 2,500,000 feet of lumber yearly, and a small carding-shop.

For 6 or 8 miles above Warrensburg the river twists about among low and extensive flats, partly timbered, and probably a half to three-quarters of a mile wide. In 6 miles by direct course from the village the river is said to have an actual length, following the windings, of 18 miles. Throughout this distance it is sluggish, but is then succeeded above by short rapids, where about 7 feet of fall was formerly in use at Richards' saw-mill, part of the old log dam still remaining. The river is at that point from 50 to 75 feet wide in a low stage, and has a bed of gravel and bowlders. The river was not examined far above this locality. Quiet water succeeds the short rapids at Richards' mill-site, and some 2 miles beyond there are rapids again, known as Hunt's falls. The hills are then said to close in, and the valley to continue quite narrow until within a few miles of Schroon lake, at which distance there is a dam, with power in use at a tannery.

Drainage areas of Schroon river.

Locality.	Square miles.
Outlet of Schroon lake, above the stream from Pottersville	304
Horicon, below Brant Lake outlet	496
Warrensburg	535
Mouth of river	556

Table of utilized power on the Hudson river and tributaries.

[Based mainly upon returns by census enumerators in 1880.]

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	H. P.	H. P.	
Hudson river	Atlantic ocean	New York	Albany	Iron castings and finishings.	1	Ordinary fall, from 7 to 8 feet.	32	22	Privilege at state dam—Troy and Green Island.
Do	do	do	do	Saw	1		50		
Do	do	do	do	Window blinds and shades.	1		74		
Do	do	do	Rensselaer	Flouring and grist	2		290		
Do	do	do	do	Machinery	1		72		
Do	do	do	do	Paper	3		720+		
Do	do	do	do	Sashes, doors, and blinds	1		55		
Do	do	do	Saratoga	Paper	1	9	500	75	Property since purchased by the Hudson River Water Power & Paper Company, and mill not in operation in the fall of 1882.
Do	do	do	do	Flouring and grist	1	7–8	60		Stillwater.
Do	do	do	do	Paper	2		140	80	
Do	do	do	do	Hosiery	3		150	75	
Do	do	do	Washington	Saw	1	9	100(?)		Saratoga dam.
Do	do	do	do	Flouring and grist	1	10–11	50±		Fort Miller.
Do	do	do	do	Paper	1		200		
Do	do	do	do	Blast-furnace	1	8			Fort Edward.
Do	do	do	do	Flouring and grist	1		90		
Do	do	do	do	Machinery	1		40		
Do	do	do	do	Paper	1		90		
Do	do	do	do	Saw	2		600(?)		
Do	do	do	do	Stone and earthen ware	1		60		
Do	do	do	do	Machinery	1	55	40		Baker's Falls.
Do	do	do	do	Paper	3		1,807		
Do	do	do	do	Saw	1	7–9	900(?)		Upper privilege at Sandy Hill.
Do	do	do	Saratoga	do	1				
Do	do	do	Saratoga and Warren.	Flouring and grist	2	40	2,000–2,100		Glens Falls privilege.
Do	do	do	do	Lime	1				
Do	do	do	do	Marble-works	1				
Do	do	do	do	Paper	1				
Do	do	do	do	Planing	2				
Do	do	do	do	Saw	2				
Do	do	do	do	do	3	14	(a)		Feeder-dam.
Do	do	do	Saratoga	Paper and wood-pulp	1	20–30	1,450–1,500		Palmer falls.
Do	do	do	do	Wood-pulp	1	13	120		Hadley.
Croton river and tributaries.	Hudson river	do	Westchester	Flouring and grist	7	105	190		
Do	do	do	do	Iron castings and finishings.	1	11	10		
Do	do	do	do	Saw	8	71+	193		
Do	do	do	do	Spectacles and eye-glasses	1	19	30	30	
Do	do	do	do	Wheelwrighting	1	7	17		
Do	do	do	do	Woolen	1	9	17		
Do	do	do	Putnam	Butter and cheese	1	8	75	580	
Do	do	do	do	Flouring and grist	9	130	164		
Do	do	do	do	Saw	3	34	85		
Do	do	do	Dutchess	Flouring and grist	1	28	20		
Do	do	Connecticut	Fairfield	Saw	1	8	15		
Murderer's creek and tributaries.	do	New York	Orange	Flouring and grist	10	197	314	40	
Do	do	do	do	Paper	2	54	424	185	
Do	do	do	do	Saw	1	12	10		
Do	do	do	do	Tannery	1	30	18		
Fishkill creek	do	do	Dutchess	Carpets	1	27	350	1,010	
Do	do	do	do	Flouring and grist	5	56	193		
Do	do	do	do	Furniture	1	4	25	25	
Do	do	do	do	Hats	2	58	400	375	
Do	do	do	do	Rubber and elastic goods	1	25	245		
Do	do	do	do	Straw goods	1	28	200	125	
Do	do	do	do	Woolen	1	22	400	300	
Tributaries	Fishkill creek	do	do	Flouring and grist	9	114	239	50	
Wappinger creek	Hudson river	do	do	Carriage and wagon materials.	1	11	65	40	

a No reliable returns; possibly as high as 1,500.

Table of utilized power on the Hudson river and tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Wappinger creek	Hudson river	New York	Dutchess	Coffins, burial-cases, and undertakers' goods.	1	9	6		
Do	do	do	do	Cotton	2	39	198		
Do	do	do	do	Flouring and grist	8	108	223		
Do	do	do	do	Paper	1	12	42	65	
Do	do	do	do	Saw	2	21	42	14	
Do	do	do	do	Wheelwrighting	1	10	10		
Do	do	do	do	Woolen	1	12	80	25	
Tributaries	Wappinger creek	do	do	Butter and cheese	1	16	8	10	
Do	do	do	do	Flouring and grist	9	109	398	50	
Do	do	do	do	Paper	1	24	24		
Do	do	do	do	Saw	4	43	57		
Do	do	do	do	Tobacco and cigars	1	12	6		
Do	do	do	do	Woolen	1	9	10		
Rondout creek and tributaries.	Hudson river	do	Ulster	Carpets	1	18	300		
Do	do	do	do	Carriage and wagon materials.	1	12	20		
Do	do	do	do	Children's carriages and sleds.	1	15	40		
Do	do	do	do	Cooperage	1	20	15	15	
Do	do	do	do	Cutlery and edge-tools	2	37	108		
Do	do	do	do	Excelsior	1	9	25		
Do	do	do	do	*Flouring and grist*	*18*	*296*	*674*		
Do	do	do	do	Furniture	1	7	15		
Do	do	do	do	Gunpowder	1	12	300		
Do	do	do	do	Lime	1	18	8	14	
Do	do	do	do	Lumber, planed	1	10	8		
Do	do	do	do	Paper	3	170	40		
Do	do	do	do	Sashes, doors, and blinds	1	12	25		
Do	do	do	do	Saw	26	370+	452		
Do	do	do	do	Tanneries	2	30	58	25	
Do	do	do	do	Wheelwrighting	1	30	6		
Do	do	do	do	Woolen	2	32	13		
Do	do	do	Sullivan	Flouring and grist	4	36+	100		
Do	do	do	do	Saw	4	53	62		
Do	do	do	Orange	Flouring and grist	21	316	532	45	
Do	do	do	do	Paper	2	40	100	200	
Do	do	do	do	Saw	12	120	249		
Do	do	do	do	Shoddy	1	13	40		
Do	do	do	do	Tanneries	2	15	14		
Do	do	do	do	Woolen	2	47	92	40	
Do	do	do	do	Worsted	1	9	90		
Do	do	New Jersey	Sussex	Agricultural implements	1	30	37		
Do	do	do	do	Flouring and grist	16	261+	470	10	
Do	do	do	do	Iron castings and finishings.	1	10	6	10	
Do	do	do	do	Saw	4	120	56		
Do	do	do	do	Tannery	1	8	8		
Do	do	do	do	Woolen	1		35		
Esopus creek	do	New York	Ulster	Carriage and wagon materials.	2	19	55		
Do	do	do	do	Flouring and grist	6	87	215	25	
Do	do	do	do	Furniture	1	8	15		
Do	do	do	do	Paints	2	20	95		
Do	do	do	do	Paper	1	31	450	320	
Do	do	do	do	Wood-pulp	1	8	80		
Do	do	do	do	Saw	16	201	570	20	
Tributaries	Esopus creek	do	do	Flouring and grist	7	109	309		
Do	do	do	do	Furniture	1	30	50		
Do	do	do	do	Paper	1	8	20	90	
Do	do	do	do	Saw	19	199+	433		
Do	do	do	do	Tannery	1	12	10	40	
Do	do	do	do	Wood turning and carving	1		20		
Do	do	do	Greene	Saw	3	48	55		
Jansen's kill and tributaries.	Hudson river	do	Columbia	Agricultural implements	1	20	4		
Do	do	do	do	Flouring and grist	4	70	94		

Table of utilized power on the Hudson river and tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Jansen's kill and tributaries.	Hudson river	New York	Columbia	Paper	3	76	250		
Do	do	do	do	Saw	3	20	23		
Do	do	do	Dutchess	Flouring and grist	4	46	84		
Catskill creek	do	do	Greene	Cotton	1		20		
Do	do	do	do	Hardware	2	22	35	12	
Do	do	do	do	Paper	1	30	50	15	
Do	do	do	do	Woolen	3	62	388	130	
Do	do	do	Albany	Flouring and grist	2	23	62		
Do	do	do	do	Saw	1	9	23		
Do	do	do	do	Tannery	1	13	28		
Do	do	do	Schoharie	Flouring and grist	2	36	40		
Do	do	do	do	Saw	1	9	35		
Tributaries	Catskill creek	do	Greene	Agricultural implements	1	14	10		
Do	do	do	do	Cooperage	2	24	18		
Do	do	do	do	Fire-arms	1	28	19		
Do	do	do	do	Flouring and grist	16	298	484	15	
Do	do	do	do	Furniture	2	26	16		
Do	do	do	do	Saw	15	196+	317	45	
Do	do	do	do	Tannery	1	12	10	25	
Do	do	do	do	Woolen	1	13	9		
Do	do	do	Albany	Flouring and grist	5	104	142		
Do	do	do	do	Paper	1	20	30	10	
Do	do	do	do	Saw	6	97	136		
Do	do	do	do	Woolen	1	9	8		
Do	do	do	Schoharie	Flouring and grist	1	16	10	12	
Do	do	do	Ulster	Saw	1	9	10		
Kinderhook creek	Hudson river	do	Columbia	Cotton	4	53+	680	265	
Do	do	do	do	Flouring and grist	2	19	133		
Do	do	do	do	Furniture	1	14	10		
Do	do	do	do	Paper	4	65	429		
Do	do	do	do	Woolen	1	10	40		
Do	do	do	Rensselaer	Flouring and grist	2	38	60		
Tributaries	Kinderhook creek	do	Columbia	Agricultural implements	3	26	16		
Do	do	do	do	Brooms and brushes	1		8		
Do	do	do	do	Cotton	3	160	358	378	
Do	do	do	do	Flouring and grist	25	524	790	40	
Do	do	do	do	Hosiery	3	23+	145	155	
Do	do	do	do	Machinery	3	59	120		
Do	do	do	do	Paper	16	291+	833	318	
Do	do	do	do	Pumps	1	20	6		
Do	do	do	do	Saw	15	274	314		
Do	do	do	do	Tannery	1	12	10		
Do	do	do	do	Upholstering materials	2	29	50		
Do	do	do	do	Woolen	1	24	75	40	
Do	do	do	Rensselaer	Blacksmithing	1	13	16		
Do	do	do	do	Flouring and grist	2	26	34		
Do	do	do	do	Paper	1	16	83		
Do	do	do	do	Saw	3	29	50		
Do	do	do	do	Wheelwrighting	1	16	10		
Do	do	do	do	Wooden handles	2	30	16		
Do	do	Massachusetts	Berkshire	Flouring and grist	1	12	9		
Do	do	do	do	Woolen	1	16	10		
Poesten kill and tributaries.	Hudson river	New York	Rensselaer	Agricultural implements	2	43	215		
Do	do	do	do	Cotton	1	28	80	220	
Do	do	do	do	Electroplating	2	41	22	30	
Do	do	do	do	Files	1	21	25		
Do	do	do	do	Flouring and grist	4	90	205		
Do	do	do	do	Hosiery	1	26	88		
Do	do	do	do	Iron castings	2	20	200	100	
Do	do	do	do	Lumber, planed	1	39	8	25	
Do	do	do	do	Machinery	1	25	70	15	
Do	do	do	do	Paper	2	67	210		Stream uncertain, but supposed to be the Poesten kill.
Do	do	do	do	Saddlery hardware	1	21	25		
Do	do	do	do	Saw	3	33	70		

Table of utilized power on the Hudson river and tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Poesten kill and tributaries.	Hudson river	New York	Rensselaer	Shirts	1	13	15		
Do	do	do	do	Steel car- and wagon-springs.	1	36	110		
Do	do	do	do	Wheelwrighting	1	13	15		
Do	do	do	do	Wire	2	50	175		
Do	do	do	do	Woolen	1	20	15		
Mohawk river	do	do	Saratoga	Flouring and grist	1	13–14	80		King's ditch, Waterford. Total water-power utilized as here enumerated, 443 horse-power.
Do	do	do	do	Hardware	2		75		
Do	do	do	do	Iron bolts, nuts, washers, and rivets.	1		20		
Do	do	do	do	Machinery	1		40		
Do	do	do	do	Paper	2		228	190	
Do	do	do	do	Hosiery	1	12	130		Himes and Vail.
Do	do	do	do	do	1	10	125		State dam, Waterford and Cohoes.
Do	do	do	Albany	Axes	1				
Do	do	do	do	Boxes, fancy and paper	1	Total fall developed above state dam, about 104 feet.	45		Harmony Mills.
Do	do	do	do	Carpentering	1		64		
Do	do	do	do	Cotton (print-cloths)	5		3,690		
Do	do	do	do	Cotton warps, batting, etc.	3–4		495		
Do	do	do	do	Cutlery and edge-tools	2		350		
Do	do	do	do	Furniture	2		50		
Do	do	do	do	Hosiery	16		1,415		Eighteen mills in fall of 1882. Cohoes. Total water-power utilized in 1880 as here enumerated, 6,556 horse-power. Increased by perhaps 300 horse-power up to the fall of 1882.
Do	do	do	do	Machinery	4		150	60	
Do	do	do	do	Paper	1		50		
Do	do	do	do	Printing and publishing	1		2		
Do	do	do	do	Sashes, doors, and blinds	1		40		
Do	do	do	do	Shirts	1		45		
Do	do	do	do	Wood-pulp	1		60		
Do	do	do	do	Wrought-iron pipe	1		106		
Do	do	do	Saratoga	Grist and saw	1	5–8	25–50		Lower aqueduct.
Do	do	do	Albany	Power supplied for pumping.	...	8	100		West Troy water-works.
Do	do	do	Herkimer	Agricultural implements	1	Total fall on 3 privileges, about 45 feet.	60		Little Falls. Total water-power in use, as here enumerated, 1,307 horse-power.
Do	do	do	do	Axes	1		100		
Do	do	do	do	Carpentering	1				
Do	do	do	do	Condensed milk	1				
Do	do	do	do	Cotton	1		75		
Do	do	do	do	Electrical apparatus	1		120		
Do	do	do	do	Fertilizers	1		50		
Do	do	do	do	Flouring and grist	1		150		
Do	do	do	do	Hardware	1		110		
Do	do	do	do	Knit underwear	2		110	50+	
Do	do	do	do	Lasts	1		7		
Do	do	do	do	Lumber, planed	2		105		
Do	do	do	do	Machinery	1		50		
Do	do	do	do	Paper	2		200		
Do	do	do	do	Saw	1		20		
Do	do	do	do	Starch	1		50	50	
Do	do	do	do	Wool extract	1		20		
Do	do	do	do	Woolen	1		80	60	
Do	do	do	Oneida	Flouring and grist	6	59	141		
Do	do	do	do	Pumping-works	1	10–12	200		Rome.
Do	do	do	do	Sashes, doors, and blinds	1	8	20		
Do	do	do	do	Saw	3	33	50		
Do	do	do	Lewis	do	2	26	45		
Schoharie creek and tributaries.	Mohawk river	do	Montgomery	Grist and saw	1	7	50±		Auriesville, main stream.
Do	do	do	do	Brooms and brushes	1	12	38		Mill Point, main stream.
Do	do	do	do	Flouring and grist	1		75		
Do	do	do	do	Saw	1		39		
Do	do	do	do	Flouring and grist	1	14	50		Charleston, main stream.
Do	do	do	do	Saw	1		30		
Do	do	do	do	Wheelwrighting	1		15		
Do	do	do	do	do	1	8	10		Location of privileges uncertain.
Do	do	do	do	Woolen	1	12	40		

Table of utilized power on the Hudson river and tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Schoharie creek and tributaries.	Mohawk river	New York	Schoharie	Agricultural implements	5	64	65		
Do	do	do	do	Carpentering	1	12	12		
Do	do	do	do	Churns	1	12	20		
Do	do	do	do	Cooperage	1	7	14		
Do	do	do	do	Flouring and grist	26	484	960		
Do	do	do	do	Furniture	1	12	12		
Do	do	do	do	Machinery	1	16	15	6	
Do	do	do	do	Paper	1	17	50	40	
Do	do	do	do	Saw	45	577	1,202	20	
Do	do	do	do	Tanneries	2	25	30		
Do	do	do	do	Wheelwrighting	2	20	18		
Do	do	do	do	Woolen	2	45	21		
Do	do	do	Greene	Cotton	1	30	75		
Do	do	do	do	Flouring and grist	4	85	143		
Do	do	do	do	Furniture	1	11	30	15	
Do	do	do	do	Saw	7	96	178		
Do	do	do	do	Tannery	1	8	5		
Do	do	do	do	Wood turning and carving	1	12	5		
Do	do	do	Albany	Flouring and grist	4	99	140		
Do	do	do	do	Saw	6	92	138		
Do	do	do	do	Tannery	1	5½	4		
Cayadutta creek	do	do	Montgomery	Flouring and grist	2	40½	170		
Do	do	do	do	Saw	1	11	20		
Do	do	do	Fulton	Flouring and grist	1	16	40	25	
Do	do	do	do	Gloves and mittens	2	38	90	4	
Do	do	do	do	Lumber, planed	1	6	8		
Do	do	do	do	Skins, dressed	16	278	454		
Tributaries	Cayadutta creek	do	do	Flouring and grist	1	15	40		
Do	do	do	do	Skins, dressed	1	14	30		
East Canada creek	Mohawk river	do	Herkimer	Cheese-boxes	1				
Do	do	do	do	Cider	1	10	60±		Ingham's Mills.
Do	do	do	do	Flouring and grist	1				
Do	do	do	do	Saw	1				
Do	do	do	do	Felt	1				
Do	do	do	do	Flouring and grist	1	20	290	170±	Dolgeville.
Do	do	do	do	Piano and organ sounding-boards.	1				
Do	do	do	do	Saw	1				
Do	do	do	Fulton	do	3	32	90		
Tributaries	East Canada creek	do	do	Cooperage	2	22	55		
Do	do	do	do	Saw	16	216	528	60	
Do	do	do	do	Tannery	1	23	70	40	
Do	do	do	Herkimer	Flouring and grist	2	43	135		
Do	do	do	do	Furniture	1	9	16		
Do	do	do	do	Saw	6	88	177		
Do	do	do	do	Shoe-pegs	1	10	20		
Do	do	do	do	Tannery	1	8	10		
Do	do	do	do	Toys and games	1	11	8		
West Canada creek	Mohawk river	do	do	Flouring and grist	1		50		
Do	do	do	do	Furniture	1				
Do	do	do	do	Hosiery	1		60	75	
Do	do	do	do	Paper	1	14, 21	150		Herkimer.
Do	do	do	do	Plaster	1				
Do	do	do	do	Sashes, doors, and blinds	2		25+		
Do	do	do	do	Saw	1		40		
Do	do	do	do	Flouring and grist	2		130		
Do	do	do	do	Saw	2		23		
Do	do	do	do	Tannery	1	20±	6		Middleville and Newport.
Do	do	do	do	Wheelwrighting	1		8		
Do	do	do	do	Saw	2	22	55		
Do	do	do	Oneida	Flouring and grist	1	14	45±		Trenton Falls.
Do	do	do	do	do	1	18	90		Prospect.
Do	do	do	do	Tannery	1		26		
Tributaries	West Canada creek	do	do	Butter and cheese	1	6	4		
Do	do	do	do	Flouring and grist	1	30	60		
Do	do	do	do	Saw	3	41	42		
Do	do	do	do	Wheelwrighting	1	30	8		

Table of utilized power on the Hudson river and tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Tributaries	West Canada creek	New York	Herkimer	Flouring and grist	6	127	101		
Do	do	do	do	Furniture	1	9	6		
Do	do	do	do	Machinery	1	14	8		
Do	do	do	do	Sashes, doors, and blinds	2	25	25		
Do	do	do	do	Saw	23	331	485		
Do	do	do	do	Saws	1	13	16		
Do	do	do	do	Tanneries	2	20	43	35	
Do	do	do	do	Wheelwrighting	1	6	16		
Do	do	do	do	Wood turning and carving	1	23	12		
Do	do	do	do	Wooden handles	1	16	20		
Do	do	do	do	Woodenware	2	23	20	8	
Do	do	do	do	Woolen	1	12	6		
Sauquoit creek	Mohawk river	do	Oneida	Agricultural implements	2	45	200		
Do	do	do	do	Cotton	4	101	1,160	1,170	
Do	do	do	do	Cotton-batting	1	4	6	6	
Do	do	do	do	Flouring and grist	3	40	155		
Do	do	do	do	Hosiery	1	10	30	50	
Do	do	do	do	Lumber, planed	1	15	35		
Do	do	do	do	Saw	3	30	140		
Do	do	do	do	Silk	1	18	50		
Do	do	do	do	Woolen	2	56	178	200	
Tributaries	Sauquoit creek	do	do	Carriages and wagons	1	7½	8		
Do	do	do	do	Furniture	1	23	12		
Do	do	do	do	Machinery	1	24	10		
Do	do	do	do	Maps and atlases	1	10	4		
Do	do	do	do	Wheelwrighting	1	10	4		
Do	do	do	do	Wood turning and carving	2	36	18		
Oriskany creek and tributaries.	Mohawk river	do	do	Carriages and wagons	1	20	15	12	
Do	do	do	do	Cotton	2	41	290		
Do	do	do	do	Cotton-batting	1	10	50		
Do	do	do	do	Felt	1	14	100	100	
Do	do	do	do	Flouring and grist	8	117	530		
Do	do	do	do	Paints	1	20	20		
Do	do	do	do	Saw	3	35	90		
Do	do	do	do	Wheelwrighting	1	9	12		
Do	do	do	do	Woolen	2	28	45		
Do	do	do	Madison	Flouring and grist	2	20	70		
Do	do	do	do	Saw	3	33	70		
Minor tributaries	do	do	Albany	Flouring and grist	1	18	20		
Do	do	do	do	Saw	1	18	20		
Do	do	do	Schenectady	Flouring and grist	4	116	160		
Do	do	do	do	Hosiery	1	40	50	80	
Do	do	do	Saratoga	Flouring and grist	5	76	375		
Do	do	do	do	Saw	7	80	176		
Do	do	do	Montgomery	Agricultural implements	1	42	50		
Do	do	do	do	Bags (not paper)	1	27	25	20	
Do	do	do	do	Bee-hives	1	12	12	20	
Do	do	do	do	Carpets	1	30	240	500	
Do	do	do	do	Carriages and wagons	1	12	17		
Do	do	do	do	Carriage and wagon materials.	2	63	49		
Do	do	do	do	Car- and carriage-springs	1	20	50	50	
Do	do	do	do	Cooperage	2	18	30		
Do	do	do	do	Cotton	1	12	30	60	
Do	do	do	do	Fertilizers	1	17	35		
Do	do	do	do	Flouring and grist	11	204	349	15	
Do	do	do	do	Hosiery	8	160+	525	605	
Do	do	do	do	Linseed-oil	1	36	150		
Do	do	do	do	Machinery	1	16	35	40	
Do	do	do	do	Maps and atlases	1	27	25	20	
Do	do	do	do	Paper	3	80	272	195	
Do	do	do	do	Pumps	1	18	15		
Do	do	do	do	Saw	11	183	341	25	
Do	do	do	do	Shoddy	1	31	92		
Do	do	do	do	Skins, dressed	1	18	12		
Do	do	do	do	Woolen	2	36	48	20	
Do	do	do	Fulton	Flouring and grist	2	38	70		

Table of utilized power on the Hudson river and tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Minor tributaries..	Mohawk river	New York	Fulton	Furniture	1	10	10	.....	
Do.....	....do	....do	... do	Gloves and mittens	1	10	10	.....	
Do.....	... do	... do	....do	Paper	7	121	245	50	
Do.....	... do	....do	....do	Saw	11	172	337	.....	
Do.....	....do	....do	....do	Shoe-pegs	1	10	10	.....	
Do	... do	....do	....do	Skins, dressed	2	14½	26	.....	
Do	....do	....do	....do	Tannery	1	15	16	.....	
Do	....do	....do	....do	Wheelwrighting	1	15	6	.....	
Do	....do	....do	....do	Wooden handles	1	17	15	.....	
Do	....do	... do	....do	Woolen	1	12	50	.....	
Do.....	... do	....do	Herkimer	Flax, dressed	1	10	12	.....	
Do.....	....do	... do	... do	Flouring and grist	6	116	205	.....	
Do.....	... do	....do	....do	Furniture	1	28	28	.....	
Do.....	....do	....do	... do	Matches	1	22	45	50	
Do.....	....do	....do	....do	Saw	9	187	261	.....	
Do.....	....do	....do	....do	Wheelbarrows	1	18	60	.....	
Do.....	....do	....do	....do	Wheelwrighting	1	8	10	.....	
Do.....	....do	....do	Oneida.....	Flouring and grist	5	60+	138	.....	
Do.....	....do	....do	... do	Hosiery	1	16	30	30	
Do.....	....do	....do	....do	Machinery	1	10	8	.....	
Do.....	... do	....do	....do	Saw	17	189+	326	.....	
Do.....	... do	... do	... do	Wheelbarrows	1	10	6	.....	
Do.....	.. do	....do	....do	Wooden packing-boxes ...	3	27	29	.....	
Do.....	....do	....do	Otsego.....	Furniture	1	10	3	.....	
Hoosac river.....	Hudson river	....do	Rensselaer...	Woolen	1	30–34	170	.....	Schaghticoke.
Do.....	....do	....do	... do	Flouring and grist	1		45±	.....	
Do.....	... do	....do	....do	Cordage and twine	3	8, 7½	310	100	Cable flax-mills.
Do.....	... do	... do	....do	Paper	1		100±	.....	
Do.....	... do	... do	....do	Gunpowder	1	8, 12	208	12	Schaghticoke.
Do.....	....do	....do	....do	Linen twines, yarns, etc ..	1	15–16	540	10	Valley Falls.
Do.....	....do	....do	....do	Knit-goods	1				
Do.....	... do	....do	....do	Flouring and grist	1				
Do.....	....do	....do	....do	Paper	1				
Do.....	... do	....do	....do	Agricultural implements, axes, etc.	1	8	159	.....	Johnsonville.
Do.....	....do	....do	....do	Flouring and grist	2		45	.....	
Do.....	....do	....do	....do	Agricultural implements .	1	19	300	160	Hoosac Falls.
Do.....	....do	Vermont.....	Bennington...	Cotton	1	17	330	250	
Do.....	....do	....do	....do	Hosiery, etc	1	9	50–60	.....	
Do.....	....do	Massachusetts..	Berkshire	Cotton	19	330	3, 048	2, 230	Including 5 privileges for the Renfrew Manufacturing Company, and 4 for the Freeman Print Works.
Do.....	....do	....do	....do	Flouring and grist	2	24	100	.....	
Do.....	....do	....do	... do	Marble-dust	1	80	90	60	
Do.....	....do	....do	....do	Paper	2	12	244	220	
Do.....	....do	....do	....do	Tannery	1	5½	17	.....	
Do.....	....do	....do	....do	Woolen	5	86	619	465	
Tributaries.....	Hoosac river	....do	....do	Cotton	2	28	52	75	
Do.....	....do	....do	....do	Flouring and grist	1	30	30	.....	
Do.....	....do	....do	....do	Kaolin and ground earths.	1	15	15	.....	
Do.....	....do	....do	....do	Machinery	1	26	15	10	
Do.....	....do	....do	....do	Tannery	1	12	15	.....	
Do.....	....do	Vermont.....	Bennington...	Carriages and wagons	1	8	8	.....	
Do.....	....do	....do	....do	Cotton	2	43	180	100	
Do.....	....do	....do	....do	Drugs and chemicals	1	15	5	.....	
Do.....	....do	....do	....do	Flouring and grist	5	69	92	.....	
Do.....	....do	... do	....do	Glass, cut, stained, and ornamented.	1	150	8	8	
Do.....	....do	... do	....do	Hardware	1	.....	15	.....	
Do.....	....do	... do	....do	Hosiery	5	97½	190	220	
Do.....	....do	....do	....do	Kaolin and ground earths.	4	115	97	.....	
Do.....	....do	....do	....do	Machinery	3	70	89	.....	
Do.....	....do	....do	....do	Paper	2	31	150	12	
Do.....	....do	....do	....do	Photographing	1	120	33	.....	
Do.....	....do	... do	....do	Saw	13	212	355	48	
Do.....	....do	....do	....do	Stone- and earthen-ware..	1	8	12	.....	
Do.....	....do	....do	....do	Tannery	1	7	16	.....	
Do.....	....do	....do	....do	Wooden packing-boxes ...	1	12	20	.....	

Table of utilized power on the Hudson river and tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Tributaries	Hoosac river	Vermont	Bennington	Wooden ware	1	15	20	.....	
Do	do	do	do	Woolen	1	16, 32	225	250	
Do	do	New York	Rensselaer	Cooperage	1	9	45	.....	
Do	do	do	do	Flouring and grist	8	107	299	10	
Do	do	do	do	Furniture	1	12	10	.....	
Do	do	do	do	Iron castings	1	10	4	.....	
Do	do	do	do	Paper	2	38	537	.....	
Do	do	do	do	Saw	10	204	271	40	
Do	do	do	do	Wooden packing-boxes	1	20	5	10	
Do	do	do	Washington	Agricultural implements	1	16	22	.....	
Do	do	do	do	Cordage and twine	2	18	120	.....	
Do	do	do	do	Flax, dressed	1	10	12	.....	
Do	do	do	do	Flouring and grist	4	82	198	.....	
Do	do	do	do	Saw	4	73	127	.....	
Fish creek	Hudson river	do	Saratoga	Flouring and grist	1				
Do	do	do	do	Machinery	1	14-20	370±	.....	Lower privilege.
Do	do	do	do	Paper	1				
Do	do	do	do	Sashes, doors, and blinds	1				
Do	do	do	do	Cotton	2	64	960	450	Saratoga Victory Manufacturing Company. About 760 horse-power actually in use.
Do	do	do	do	Grist and saw	1	14	115	.....	
Kayaderosseras creek and tributaries.	Fish creek	do	do	Agricultural implements	3	49	391	137	
Do	do	do	do	Flouring and grist	11	171	370	.....	
Do	do	do	do	Machinery	1	11	57	.....	
Do	do	do	do	Paper	10	157	1,012	790	
Do	do	do	do	Paper bags	1	20	13	7	
Do	do	do	do	Paper collars and cuffs	1	18	77	25	
Do	do	do	do	Sashes, doors, and blinds	1	11	37	.....	
Do	do	do	do	Saw	9	110+	243	25	
Do	do	do	do	Tanneries	3	31+	65	75	
Do	do	do	do	Wheelwrighting	1	11	7	.....	
Other tributaries	do	do	do	Saw	1	10	26	.....	
Batten kill	Hudson river	do	Washington	Plaster	1				
Do	do	do	do	Sashes, doors, and blinds	1	10	.....	.....	Clark's Mills.
Do	do	do	do	Saw	1				
Do	do	do	do	Blankets	1				
Do	do	do	do	*Flouring and grist*	1				
Do	do	do	do	Saw and plaster	1	47	565±	.....	Middle Falls.
Do	do	do	do	Wood-pulp and leather-board.	1				
Do	do	do	do	Linen threads, yarns, and twines.	1	11½	130	.....	
Do	do	do	do	Cotton-batting	1				
Do	do	do	do	Flouring and grist	1				
Do	do	do	do	Flax, dressed	1	10-12	250±	.....	Greenwich.
Do	do	do	do	Shirts	1				
Do	do	do	do	Saw	1				
Do	do	do	do	Knit underwear	1	7½	70	.....	
Do	do	do	do	Paper	1		60	.....	
Do	do	do	do	Flouring and grist	1				
Do	do	do	do	Paper	1	9	175±	.....	Battenville.
Do	do	do	do	Saw	1				
Do	do	do	do	Blankets	1				
Do	do	do	do	Flouring and grist	1	7½	180±	.....	East Greenwich.
Do	do	do	do	Sashes and blinds	1				
Do	do	do	do	Saw	1				
Do	do	do	do	Marble sawed	1	7	24	.....	Baxterville.
Do	do	do	do	Iron foundery	1				
Do	do	do	do	Flouring and grist	1				
Do	do	do	do	Saw	1	7	120±	.....	Shushan.
Do	do	do	do	Shirts	1				
Do	do	do	do	Woolen	1				
Do	do	do	do	do	1	6	30	.....	
Do	do	Vermont	Bennington	Brooms and brushes	1	7	35	.....	
Do	do	do	do	Marble and stone-works	2	40	90	40	
Do	do	do	do	Saw	3	22+	105	.....	

Table of utilized power on the Hudson river and tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Tributaries	Batten kill	Vermont	Bennington	Brooms and brushes	1	19	55		
Do	do	do	do	Cooperage	1	16	25		
Do	do	do	do	Flouring and grist	5	87	100		
Do	do	do	do	Furniture	1	13	40		
Do	do	do	do	Iron castings	1	13	12		
Do	do	do	do	Leather, tanned and curried.	1	12	15	30	
Do	do	do	do	Lumber, planed	1	9	18		
Do	do	do	do	Machinery	1	4	4		
Do	do	do	do	Saw	18	400+	590	60	
Do	do	do	do	Wooden handles	3	42	42		
Do	do	do	do	Wooden ware	3	55	44		
Do	do	New York	Washington	Agricultural implements	1	20	12		
Do	do	do	do	Flax, dressed	1	8	15		
Do	do	do	do	Flouring and grist	3	38	155		
Do	do	do	do	Saw	3	31	95	35	
Do	do	do	do	Starch	1	14	12		
Sacondaga river	Hudson river	do	Saratoga	Wood-pulp	2	27	650±		Hadley.
Do	do	do	do	Wooden ware	1	} 12			Do.
Do	do	do	do	Tannery	1				
Do	do	do	do	Flouring and grist	1	20	30		Providence.
Do	do	do	Hamilton	Saw	1	10	20		Wells.
Do	do	do	do	Tanneries	2	8	58	50	Hope.
Tributaries	Sacondaga river	do	do	Lumber, planed	1	21	40		
Do	do	do	do	Saw	6	67	169		
Do	do	do	do	Tanneries	2	21	70	102	
Do	do	do	Fulton	Agricultural implements	1	8	10		
Do	do	do	do	Blacksmithing	1	11	10		
Do	do	do	do	Cooperage	2	26	40		
Do	do	do	do	Flouring and grist	6	82	274	45	
Do	do	do	do	Iron castings and finishings.	1	6	6		
Do	do	do	do	Lumber, planed	1	9	20		
Do	do	do	do	Paper	5	63	105	70	
Do	do	do	do	Saw	17	222	477	50	
Do	do	do	do	Shoe-pegs	1	10	10		
Do	do	do	do	Skins, dressed	2	22	29	16	
Do	do	do	do	Tanneries	3	17+	36	35	
Do	do	do	do	Wooden ware	1	11	18	15	
Do	do	do	do	Woolen	1	20	14	20	
Do	do	do	Saratoga	Agricultural implements	2	19	34	47	
Do	do	do	do	Flouring and grist	4	60	190		
Do	do	do	do	Furniture	2	28	23		
Do	do	do	do	Machinery	1	15	15		
Do	do	do	do	Saw	14	238	363	20	
Do	do	do	do	Tanneries	2	33	27		
Do	do	do	do	Wheelwrighting	1	13	20		
Do	do	do	do	Wooden ware	2	34	50		
Schroon river and tributaries.	Hudson river	do	Warren	Wool carding	1		18		
Do	do	do	do	Flouring and grist	3	30	185		
Do	do	do	do	Planing	1				
Do	do	do	do	Sashes, doors, and blinds	1				
Do	do	do	do	Saw	2				
Do	do	do	do	Shoe-pegs	1				
Do	do	do	do	Tannery	1				
Do	do	do	do	Wood-pulp	1	12	150		
Do	do	do	do	Woolen	2	16	30		
Do	do	do	Essex	Flouring and grist	2	36	60		
Do	do	do	do	Saw	12	150	534		
Do	do	do	do	Tannery	1	12	60		
All other tributaries.	do	do	Westchester	Carpets	1	12	40	760	
Do	do	do	do	Cutlery and edge-tools	1	26	40	50	
Do	do	do	do	Fertilizers	1	35	41	22	
Do	do	do	do	Files	1	17	22	40	
Do	do	do	do	Flouring and grist	8	126	352	95	
Do	do	do	do	Sashes, doors, and blinds	1	13	8	10	

Table of utilized power on the Hudson river and tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H.P.*	*H.P.*	
All other tributaries.	Hudson river	New York	Westchester	Silk	3	27+	97	165	
Do	do	do	do	Tannery	1	18	10	20	
Do	do	do	do	Wheelwrighting	1	23	6		
Do	do	do	do	Wire-works	1	25	44	185	
Do	do	do	Rockland	Flouring and grist	2	34	40		
Do	do	do	Orange	do	6	112	127		
Do	do	do	do	Machinery	2	20	24		
Do	do	do	do	Marble and stone-works	1		6		
Do	do	do	do	Paper	2	35	215	105	
Do	do	do	do	Saw	2	25	24		
Do	do	do	do	Tanneries	2	30½	80		
Do	do	do	do	Woolen	5	78	311	300	
Do	do	do	Putnam	Flouring and grist	2	35	50		
Do	do	do	do	Paper	2	48	95	180	
Do	do	do	Ulster	Baskets, rattan- and willow-ware	1	33	12	50	
Do	do	do	do	Carriage and wagon materials	1	14	18		
Do	do	do	do	Cutlery and edge-tools	2	21	66	81	
Do	do	do	do	Dye woods, dye-stuffs, and extracts	1	24	25		
Do	do	do	do	Excelsior	1	12	50	120	
Do	do	do	do	Flouring and grist	12	232	295		
Do	do	do	do	Paints	1	30	40		
Do	do	do	do	Saw	6	91+	117		
Do	do	do	do	Wheelbarrows	1	18	20	25	
Do	do	do	do	Woolen	2	61	44		
Do	do	do	Dutchess	Carpets	1	18	50	80	
Do	do	do	do	Cutlery and edge-tools	1	20	26		
Do	do	do	do	Dye woods, dye-stuffs, and extracts	1	40	270	380	
Do	do	do	do	Flouring and grist	5	95	178	50	
Do	do	do	do	Hats	1	22	200	150	
Do	do	do	do	Saw	4	49½	72		
Do	do	do	do	Wood turning and carving	1	50	20	25	
Do	do	do	do	Woolen	1	12	26		
Do	do	do	Greene	Flouring and grist	4	110+	85	30	
Do	do	do	do	Paper	1	23	30		
Do	do	do	do	Saw	6	79+	103	35	
Do	do	do	do	Wooden ware	1	18	15		
Do	do	do	Albany	Flouring and grist	6	127	210		
Do	do	do	do	Hosiery	1	14	41		
Do	do	do	do	Paper	3	58	183	120	
Do	do	do	do	Saw	7	136	162		
Do	do	do	Rensselaer	Agricultural implements	2	44	36	10	
Do	do	do	do	Cordage and twine	2	25	35		
Do	do	do	do	Cotton	1	28	78		
Do	do	do	do	Drugs and chemicals	1	50	30		
Do	do	do	do	Flouring and grist	9	202	394		
Do	do	do	do	Hosiery	4	79	205		
Do	do	do	do	Paints	2	33	128		
Do	do	do	do	Paper	2	114½	175	150	
Do	do	do	do	Saw	7	120	113		
Do	do	do	do	Woolen	2	25	18		
Do	do	do	Saratoga	Cordage and twine	1	22	14		
Do	do	do	do	Fertilizers	2	30	85		
Do	do	do	do	Flouring and grist	11	179	386		
Do	do	do	do	Saw	6	74	142		
Do	do	do	do	Sashes, doors, and blinds	2	12	47		
Do	do	do	do	Woolen	1	12	16		
Do	do	do	Washington	Fertilizers	1		30		
Do	do	do	do	Flax, dressed	2	48	18		
Do	do	do	do	Flouring and grist	3	35½	108		
Do	do	do	do	Saw	3	61	100		
Do	do	do	do	Vinegar	2	23½	46		
Do	do	do	Warren	Flouring and grist	4	47	180		
Do	do	do	Essex	Saw	2	22	80		

Summary of utilized power on the

	Stream.	COTTON-MILLS.			WOOLEN-MILLS. (a)			HOSIERY- AND KNIT-UNDERWEAR MILLS.			PAPER-MILLS.			FLOURING- AND GRIST-MILLS.		
		Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.
			H. P.	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*
1	Hudson river	....	.....	.....	....	.. ...	.....	3	150	75	13	5,057	155	7	820	.....
2	Croton river and tributaries	....	.....	... .	1	17	.....	..	.. ....	.....	..	.....	.....	17	382	.....
3	Murderer's creek and tributaries	....	.....	.....	....	.....	.....	..	.....	.....	2	424	185	10	314	40
4	Fishkill creek and tributaries	...	.....	.....	2	750	1,310	....	.....	.....	....	.. ....	.....	14	432	50
5	Wappinger creek and tributaries	2	198	.....	2	90	25	...	.....	.....	2	66	65	17	621	50
6	Rondout creek and tributaries	....	.....	.. ...	7	530	40	..	.....	.....	5	240	240	50	1,776	55
7	Esopus creek and tributaries	....	.....	.....	....	.....	.....	....	.....	.....	2	470	410	13	524	25
8	Jansen's kill and tributaries	...	.....	.....	....	.....	.....	..	.....	.....	3	250	.....	8	178	....
9	Catskill creek and tributaries	1	20	.....	5	405	130	..	.....	...	2	80	25	26	738	27
10	Kinderhook creek and tributaries	7	1,038	643	3	125	40	3	145	155	21	1,345	318	32	1,026	40
11	Poesten kill and tributaries	1	80	220	1	15	.....	1	88	.....	2	210	.. ...	4	295	.....
12	Mohawk river and tributaries	15	5,871	1,236	13	708	780	32	2,475	890	17	1,195	475	113	4,821	40
13	Hoosac river and tributaries	25	3,690	2,655	7	1,014	715	6	240	220	8	1,151	232	24	849	10
14	Fish creek and tributaries	2	960	450	....	.. ...	... ..	....	.....	.....	13	1,324	822	13	595	.....
15	Batten kill and tributaries	1	10	.....	4	112	.....	1	70	.....	2	135	.....	13	673	.....
16	Sacondaga river and tributaries	....	.....	.....	1	14	20	..	.....	.....	5	105	70	11	494	45
17	Schroon river and tributaries	...	.....	.....	2	30	.....	....	.....	.....	...	.....	.. ...	5	245	.....
18	All other tributaries of the Hudson river	1	78	.....	13	505	1,140	5	246	.....	10	698	645	72	2,405	175
	Total, Hudson river and all tributaries	55	11,945	5,204	61	4,315	4,200	51	3,414	1,340	107	12,750	3,642	458	17,180	557

a Including also carpet factories, of which there are several on the streams mentioned.

b Comprising iron-furnaces, blacksmithing and electro-plating shops, and works for the manufacture of agricultural implements, axes, cutlery and sundry saws, steel car- and wagon springs, wire, and wrought-iron pipe.

c Comprising carpentering, cooperage, wheelwrighting, and wood-turning and carving shops; and establishments for the manufacture of carriages and wagons, organ sounding-boards; sashes, doors, and blinds; shoe-pegs, wheelbarrows, wooden packing-boxes, wooden handles, and wooden ware.

d Comprising works for dressing flax; cutting, staining, and ornamenting glass; working in marble and stone; printing and publishing; dressing skins; and boxes, brooms and brushes, butter and cheese, cider, condensed milk, drugs and chemicals; dye-woods, dye-stuffs, and extracts; felt, fertilizers, gloves and mittens, goods, shirts, shoddy, silk, spectacles and eye-glasses, starch, stone- and earthen-ware, straw goods, tobacco and cigars, toys and games, upholstering materials, vinegar,

Hudson river and tributaries.

SAW-MILLS.			METAL-WORKING ESTABLISHMENTS. (b)			WOOD-WORKING ESTABLISHMENTS. (c)			TANNERIES.			SUNDRY OTHER ESTABLISHMENTS. (d)			TOTAL.			
Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	
	H.P.	*H.P.*		*H.P.*	*H.P.*		*H.P.*	*H.P.*		*H.P.*	*H.P.*		*H.P.*	*H.P.*		*H.P.*	*H.P.*	
11	4,750	.....	5	184	22	4	219	.....	.....	.....	.....	4	265	.....	47	11,445	252	1
12	293	.....	1	10	.....	1	17	.....	.....	.....	.....	2	105	610	34	825	610	2
1	10	.....	.....	.....	.....	.....	.....	.....	1	18	.....	.....	.....	.....	14	766	225	3
.....	.....	.....	.....	.....	.....	1	25	25	.....	.....	.....	4	845	500	21	2,052	1,885	4
6	99	14	.....	.....	.....	3	81	40	.....	.....	.....	2	14	10	34	1,169	204	5
46	819	.....	4	151	10	8	154	15	5	80	25	3	348	14	137	4,098	399	6
38	1,058	20	.....	.....	.....	5	140	.....	1	10	40	3	175	.....	62	2,377	495	7
3	23	.....	1	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15	455	.....	8
.24	521	45	4	64	12	4	34	.....	2	38	25	.....	.....	.....	68	1,900	264	9
18	364	.....	8	158	.....	4	36	.....	1	10	.....	3	58	.....	100	4,305	1,196	10
3	70	.....	12	842	145	2	23	25	.....	.....	.....	1	15	.....	27	1,638	390	11
190	5,013	105	32	1,647	156	65	1,163	105	11	210	75	50	1,884	194	538	24,987	4,056	12
27	753	88	9	595	170	6	108	10	3	48	.....	18	1,210	180	133	9,658	4,280	13
10	269	25	5	455	137	3	54	.....	3	65	75	.....	.....	.....	49	3,722	1,509	14
30	1,021	95	4	73	.....	11	204	.....	1	15	30	14	901	40	81	3,214	165	15
38	1,029	70	6	75	47	12	221	15	10	191	187	4	679	16	87	2,808	470	16
14	534	.....	.....	.....	.....	3	.....	.....	2	60	.....	2	168	.....	28	1,037	.....	17
43	913	35	10	258	316	9	184	180	3	90	20	23	1,077	767	189	6,454	3,278	18
514	17,539	497	101	4,516	1,015	141	2,663	415	43	835	477	133	7,744	2,331	1,664	82,910	19,678	

edge-tools, electrical apparatus, files, fire-arms; iron bolts, nuts, washers, and rivets; iron castings and finishings, saddlery and general hardware, machinery, pumps, carriage and wagon materials, children's carriages and sleds, cheese-boxes, churns; coffins, burial-cases and undertakers' goods, excelsior, furniture, piano and water-supply pumping; also photographing and wool-carding shops, and establishments for the manufacture of bags, baskets, rattan- and willow-ware, fancy and paper gunpowder, hats, kaolin and ground earths, lasts, lime, linseed-oil, leather-board; linen threads, yarns, and twines: maps and atlases, paints, plaster, rubber and elastic wood-pulp, and wool extract.

REPORT

ON THE

WATER-POWER OF LAKE GEORGE OUTLET.

403—61

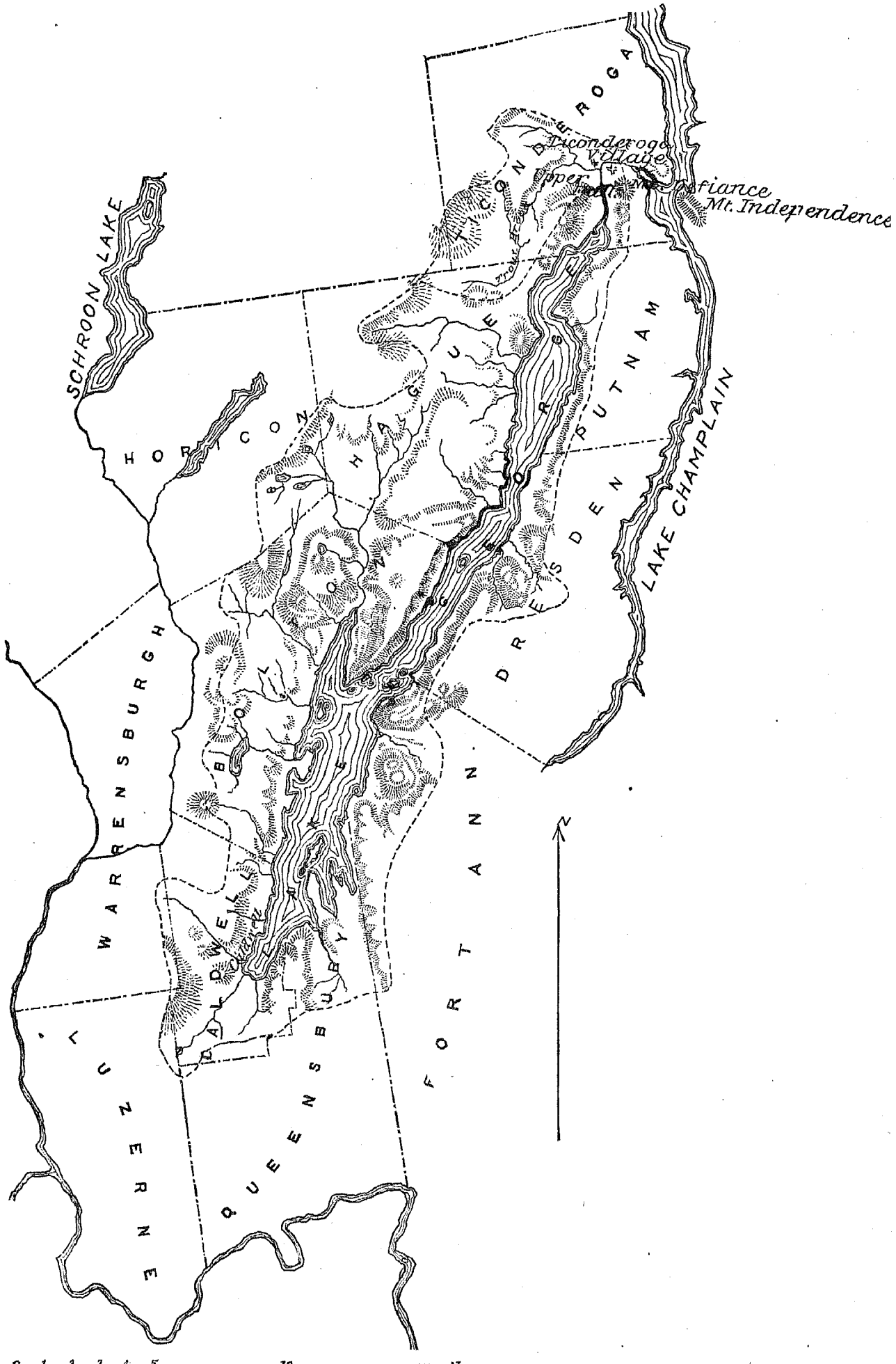

FIG. 9 - Map of the L. L. C[illegible]

63-405

LAKE GEORGE OUTLET.

The beautiful sheet of water known as lake George lies in eastern New York state, opposite and a little to the west of the head of lake Champlain. It is 230 feet higher than the latter, into which its waters discharge from the northern extremity through Ticonderoga creek, 2½ miles long. The length of the lake is about 32 miles; its width varies in general from 1 to 2 miles, but reaches 2½ miles at a point near the head. The surface flowed amounts to 44 square miles, including the islands, which are numerous but small. The area tributary to the lake and its outlet is 238 square miles at the upper falls, and 262 square miles at the entrance into lake Champlain.

Lake George is bordered by high hills, or mountains, whose rocky slopes often rise precipitously from its shores. At its foot, where the width contracts, there are level meadows. Below the lake proper is a narrow arm reaching about a mile northward to the upper falls, and nowhere more than a few hundred feet across. The ranges of mountains which inclose the lake are there perhaps a mile apart, with rolling or moderately hilly land intervening. The range on the west runs off to the northward, and remains of quite uniform height except as it is now and then cut through transversely by valleys. The hills on the east side of the lower end of the lake subside somewhat, and striking to the eastward come to an abrupt end on the shore of lake Champlain. The latter is here about 1,400 feet wide, and on the opposite side the range is continued, beginning at mount Independence as suddenly as it had previously dropped off on the west shore at mount Defiance. The narrow arm of the lake terminates at the upper dam on the outlet, where the storage is controlled, and from there Ticonderoga creek runs down through a comparatively open valley, practically its entire descent being accomplished in the first mile. The fall is in two or three principal pitches, and is almost wholly over hard granitic and quartzose rock.

The lake is deep, and its sides dip steeply beneath the water. A depth of 100 feet will often be found within 30 feet of the shore; and within a few miles of the outlet, where the depth is greatest, it is said that soundings of 400 feet have failed to reach bottom. The water in the main body of the lake is wonderfully clear, and objects can plainly be seen 40 feet beneath the surface. In the narrow arm at the foot of the lake, however, there is a clayey bed which becomes stirred up and gives the water there and in the outlet a milky hue. A number of small streams, none more than 6 or 8 miles long, flow into the lake, but it is thought to receive a large portion of its water from hidden springs in the bed.

A short distance above the upper dam water is taken out for the village of Ticonderoga. About 1,500 people are supplied, under a head of 200 feet, by means of an 8-inch main having an estimated capacity of 470,000 gallons per twenty-four hours. The project has recently been broached of furnishing the various cities along the Hudson valley, down to and including New York, with water from this lake, though it is not probable that any advanced steps have been taken in the enterprise. The question is one of much importance to the inhabitants of the village of Ticonderoga, for the carrying out of the design would curtail their principal resource. Even supposing the plan practicable, its execution would probably meet with determined opposition.

The outlet, Ticonderoga creek, after passing for a mile or so down through the village, becomes slack-water on to lake Champlain. In colonial times freight was brought up in vessels to the lower falls, transferred to the lake, and shipped to its head, on the way to fort Edward. Lake George thus served as an important highway of traffic, and the reason is seen why the entrance was so strongly defended by forts. Previously to 1837 navigation to the lower falls seems to have been unimpeded; but in those times there was a saw-mill at the falls, supplied with logs rafted down the lake and floated over the upper falls, and the refuse of sawdust and slabs from this mill gradually choked up the channel until it became no longer navigable, in which condition it has remained to the present time. But under an appropriation made by the general government the channel is now being dredged out, and a depth of 7 feet will be obtained, so that canal-boats or propellers can come directly to the mills in the lower part of the village.

Ticonderoga is a pretty and flourishing place. A branch from the Delaware and Hudson Canal Company's railroad brings passengers in summer to the foot of the lake, and transports freight throughout the year. The village station is distant not over half a mile from most of the mills, and the uppermost of these is close by the track. The charges for freight were stated by one of the largest manufacturers to be very favorable.

At the extremity of the arm of the lake there is a natural abrupt fall of say 12 feet over a granite ledge. A dam 6 or 7 feet high has been built at the top of the ledge, controlling the lake and increasing the fall to about 18 feet. The dam is an old structure of timber, 60 or 65 feet long. The lake fills regularly in spring, and ordinarily reaches a height about 18 inches above the crest of the dam. It is said that wealthy owners of real estate on the shores of the lake will not permit its surface to be artificially sustained by flash-boards on the dam, and in consequence a large amount of water runs to waste in spring. The highest stage is gained in April or May, after which the level steadily declines until a minimum is reached in September. The water never rises more than about 2 feet above the crest of the dam, and never sinks more than about 1 foot below it. It falls to the crest usually by August 1, and remains below until November or December.

There is no association of the mill-owners here, but the discharge from the lake is controlled entirely by the proprietor of the upper privilege. He endeavors to pass down uniformly what he considers to be the natural flow. Many of the establishments below are small or of but moderate size, and for these the supply is commonly sufficient; but some of the larger concerns are short of water in the fall. The flow from the lake does not appear to be managed in the most economical manner. As has been said, there is a large wastage over the dam in spring, and, considering that there is a deficiency of supply in the fall, and that the raising of the dam by flash-boards or otherwise is not allowed, it would certainly seem better policy to draw down the lake another foot or two in the dry season, and so make the discharge entirely uniform throughout the year. The head at the upper falls would be but slightly diminished, and the loss would be largely compensated by the increased volume in low water.

The actual discharge from the lake has been repeatedly measured,(*a*) and found to vary between an ordinary maximum of about 660 and an ordinary minimum of about 330 cubic feet per second, although a few years ago it fell even lower than this. July 10, 1880, the flow was at the rate of 580 cubic feet per second, although the two preceding years had been unusually dry and the volume in consequence somewhat diminished. The rainfall on the drainage basin may be taken as, approximately, 9 inches in spring, 10 in summer, 11 in autumn, 8 in winter, and 38 for the year. Judging from the above figures for the maximum and minimum, the average discharge for the year may be estimated as not far from 450 cubic feet per second, which is equivalent to about 68 per cent. of the 38 inches of rainfall on the entire basin (including the lake surface) of 238 square miles tributary at the upper falls. It is stated that in 1839 Mr. William J. McAlpine made an examination of the water-power at this point, and measured the discharge as 429 cubic feet per second. This is presumed to have been before the lake was controlled by a dam at the outlet; but as neither that fact nor the stage of water is mentioned in the information at hand, the gauging is not perhaps of especial assistance in this connection.

In the report of Mr. McAlpine's survey the fall is given as follows: From the lake to the foot of the upper falls, 102.39 feet; thence to Trout Brook inlet, 26.27 feet; thence to water-surface in the bay communicating with lake Champlain, 91.43 feet; making a total of 220.09 feet. Mr. D. M. Arnold states the fall from water-surface in lake George to that in lake Champlain to be about 230 feet, which is of course liable to some variation with the stages of water in the two lakes.(*b*)

It is easy to see that the opportunities for the use of water-power afforded by the outlet of lake George must be very fine. The valley is open and perfectly accessible throughout the length of the falls. Railway communications are favorable. The lake holds back the water so as to insure entire immunity from freshets, and yields a remarkably uniform flow. It usually closes with ice between Christmas and the last of January, and opens in the month of April. The warmth of its water is such that anchor-ice seldom gives any trouble, and then only for a day or two during exceptionally cold weather, when the ground is bare and frozen hard. In addition to these advantages the water is very clear and soft, and thus well suited to use in paper-manufacturing.

Descending from the lake the privileges met are, in order, as follows:

1. At the outlet is a power owned by George C. Weed and leased by the Lake George Pulp & Paper Company. The fall is 18 feet. On the right bank is a small saw-mill with 50 horse-power of wheels, and a fine new paper-mill. The latter was nearly completed when visited in November, 1882, and was soon to start in the manufacture of news-paper, with a capacity for producing 4 tons per day. The mill has 290 horse-power of wheels, and is designed for the manufacture of either news-, wall-, or manila-paper. On the left bank is a dry-pulp mill using 150 horse-power. In the year before it was visited its production was 200 tons of pulp, and it has a capacity for 600 tons.

2. Fall of 18 feet owned and operated by the same parties as above; 250 horse-power of wheels is used in

a For knowledge of the results obtained, and for much general information concerning the lake and the water-power of its outlet, thanks are due to Mr. D. M. Arnold, civil engineer, of Ticonderoga.

b As we have seen, lake George is subject to an extreme variation in surface-level of about 3 feet. Lake Champlain loses largely in summer by evaporation and drainage, getting very low toward the end of the season and rising high again in late spring; it is thus subject to an annual oscillation of about 8 feet.

grinding wet pulp, of which the production is 2 tons per day. The tail-water from the saw-mill on the upper fall is utilized on the second fall, under a head of 12 feet, by George C. Weed's planing-mill. About 40 horse-power is estimated to be obtained from an old scroll-wheel.

3. Immediately below the second privilege a low rude dam, a couple of feet high, diverts a portion of the water of the stream into a race on the right bank. The race is continued by an open wooden flume 6 or 7 feet wide and 300 feet long. From the extremity of this, water passes on a heavy incline through an iron tube down to the cotton-mill of the Lake George Manufacturing Company. The tube is 5 feet in diameter, $\frac{3}{16}$ of an inch thick, and about 240 feet long. The company owns about 75 feet of fall and half the flow of the creek. The head actually utilized is 68 feet, under which two Swain turbines of 400 aggregate horse-power are run, the two wheels acting upon a single vertical shaft. Only 175 or 200 horse-power is in active use, and of course not nearly all the water of the creek. The company employs 150 hands, runs 10,000 spindles and 252 looms, and manufactures fine sheetings, of which its production is 55,000 yards per week. The other half of this privilege can be improved in a manner similar to that just described, and would furnish a splendid power. It is owned by the American Graphite Company, which has works at the lower falls in the village.

4. Succeeding the 75 feet owned by the Lake George Manufacturing Company there is an available unimproved fall of about 13 feet, owned on the east side by W. E. Calkins and the Glens Falls Pulp Company, and on the west by W. E. Calkins and the heirs of John Lewis, deceased.

5. A fall of 13 feet, owned and used by the Glens Falls Pulp Company in the manufacture of mechanical wood-pulp from poplar and spruce. This company employs 250 horse-power of wheels and turns out about 800 tons, dry weight, of pulp in the course of a year. Ordinarily the supply of water is ample throughout the year, but for a couple of months, say once in five years, the manager states that the works can be run at only one-half or three-quarters of their full capacity. The dam is of log crib-work and stone. A small trout-brook, 6 or 8 miles long, empties into the mill-pond, and is of considerable assistance at times, though not of much use in low water. It may be said in general of the water-privileges on Ticonderoga creek that the dams are short, cheap, and unimportant. The pondage formed by them is very small, and in most cases of no consequence whatever.

6. By means of a low dam of timber and stone and a short wooden flume, water is diverted to S. J. Moore & Son's 3-run grist-mill, where 56 horse-power of wheels is run under a fall of 6½ or 7 feet.

The stream now divides, and a small branch running off to the right incloses an island and then joins the main creek again, furnishing power in the interval to Hooper & Co.'s machine-shop, Patterson & Merchant's grist-mill, and two other small establishments. Continuing down the main stream, we have:

7. A fall of 5 feet, at which from 5 to 10 horse-power is used in J. W. Treadway's 1-set mill for the manufacture of plain and fancy cassimeres. A small race on the opposite bank supplies the sash, door, and blind factory of the C. P. Fobes Co-operative Union. This concern has a fall of about 8 feet and owns water for 25 horse-power, but uses only a small part of this.

8. A fall of 10 feet used in J. Q. A. Treadway's 2-set fancy-cassimere mill. About 25 horse-power is said to be employed.

9. Privilege known as the "island property", embracing a fall variously stated at from 30 to 40 feet, and utilized to only an insignificant extent in a little shop for re-cutting files. The privilege is a valuable one and offers a good building-site. It is owned by the Rogers estate and Burleigh Brothers, of Ticonderoga.

10. The main stream, having been rejoined by the small branch which forms the island, soon after passes over a low weir with a fall of 2 or 3 feet. A stout division-wall of masonry runs thence some distance down stream to the last dam. No power is used from the fall at the weir, and its only purpose is to divide the flow of the stream. It has a length of 75 feet, and the division-wall is 50 feet from the right bank. Consequently two-thirds of the flow passes down to the right and one-third to the left. The privilege at the lower dam yields an effective fall of 30 feet, and is utilized on both sides of the river. On the right bank are the works of the Ticonderoga Pulp & Paper Company. This company previously had a mill here for grinding wood-pulp, and in November, 1882, had just completed a fine new mill for chemical pulp, with a capacity for producing about 5 tons per day. On the left bank are the works of the American Graphite Company, which were found to be shut down for the winter, and Cyrus Butler's iron-works, which were closed temporarily at least, and probably permanently. The Graphite company has 3 wheels with an aggregate of 165 horse-power; the iron-works receive water through a separate flume, and have 2 wheels furnishing together about 75 horse-power.

With this privilege the fall of the creek is practically finished and we are brought down to slack-water. From the description that has been given, it may be seen that the manufacture of pulp and paper is the most prominent industry on this outlet, and it is the one to which the locality seems best suited. There is evidently a large amount of fall either partially or entirely undeveloped. In particular, there is the fall in the upper village, owned by the American Graphite Company and embracing from 68 to 75 feet,(a) with half the flow of the stream; 13 feet immediately below which is entirely unemployed; and the "island property" in the lower village, with from 30 to 40 feet of fall. Besides

a It could not be definitely ascertained whether the property on the left bank covers more than the 68 feet of fall the power of which is utilized on the opposite side by the Lake George Manufacturing Company.

these there are various falls at which but a small proportion of the available power is put to use. From the best data at hand the power at the various falls may be estimated as in the table below:

Summary of water-privileges on Lake George outlet (in order from the upper falls), with estimate of available power.

Party owning or occupying privilege.	Manufacture.	Fall.	THEORETICAL HORSE-POWER, BASED ON AVERAGE FLOW FOR THE 24 HOURS.			Effective horse-power of wheels in use.	Remarks.
			Ordinary minimum. (a)	Ordinary maximum. (b)	Average for the year. (c)		
		Feet.					
George C. Weed owns privilege and leases to Lake George Pulp & Paper Company.	Dry pulp and news-paper manufactured, and small power used by saw-mill.	18	675	1,350	920	490	Storage of lake controlled at the dam. Capacity of pulp-mill, 600 tons per annum; of paper-mill, 4 tons per day.
George C. Weed owns privilege and leases main portion to Lake George Pulp & Paper Company.	Wood-pulp ground, and small power used in Weed's planing-mill.	18	675	1,350	920	290	Production of pulp-mill, 2 tons per day.
Owned and used on right bank by Lake George Manufacturing Company. The other half is owned by the American Graphite Company, and is not used.	Fine sheetings	*d*75	2,810	5,620	3,830	175–200	The privilege affords a splendid unemployed power. The cotton-mill has 10,000 spindles, 252 looms, and 400 horse-power of wheels in place.
Power on east bank owned by Glens Falls Pulp Company and W. E. Calkins; on west bank by W. E. Calkins and heirs of John Lewis, deceased.	Entirely unimproved	13	490	980	660	.....	
Glens Falls Pulp Company	Mechanical wood-pulp	13	490	980	660	250	Production, 800 tons per annum.
S. J. Moore & Son	Power used for 3-run grist-mill.	6½–7	260	520	360	50	
On a branch striking off from the main stream just below Moore's mill are several small powers.	Power used in carpenter-shop, machine-shop, grist-mill, and wheelwright-shop.	.....	.....	.....	.....	100±	
C. P. Fobes Co-operative Union (right bank).	Sashes, doors, and blinds	.....	.....	.....	.....	10±	Takes water from same pool as J. W. Treadway, and returns it farther down stream.
J. W. Treadway (left bank)	Plain and fancy cassimeres.	5	*e*170	*e*360	*e*240	5–10	One set of cards.
J. Q. A. Treadway	Fancy cassimeres	10	*e*340	*e*720	*e*480	25	Two sets of cards.
"Island privilege", owned by Rogers estate and Burleigh Brothers.	Substantially unemployed	30–40	*e*1,020–1,360	*e*2,150–2,860	*e*1,430–1,910	.....	Fine site.
Ticonderoga Pulp & Paper Company	Pulp and paper	30	1,125	2,250	1,530	.....	
American Graphite Company	.....					165	Not running in the fall of 1882.
Cyrus Butler	Iron-works					75	Works closed.
Power on outlet for assumed fall of 1 foot	.....	1	37.5	75	51.12	.....	In exceptional years the minimum power sinks below the figures here given. With suitable management of the storage in the lake the average flow from it could be made uniformly available through the year.
Total power on outlet, assuming fall at 220 feet.	.....	220	8,250	16,500	11,250	*f*1,600–1,700	
Total power on outlet, assuming fall at 230 feet.	.....	230	8,625	17,250	11,760		

a Flow assumed at 330 cubic feet per second.

b Flow assumed at 660 cubic feet per second.

c Flow assumed at 450 cubic feet per second.

d Possibly the Graphite company's property covers but 68 feet of fall.

e The small branch running to the right of the island somewhat diminishes the volume of the main stream. For the three falls indicated the reduction has arbitrarily been assumed to be 30 cubic feet per second.

f Not including the power used by the Ticonderoga Pulp & Paper Company.

67-409

INDEX TO REPORT ON WATER-POWER OF HUDSON RIVER BASIN AND LAKE GEORGE OUTLET.