

The summit or mountain division was actually surveyed. We ran a line with the compass and chain, inclosing the 105 square miles heretofore mentioned. We ran a girt line of levels with the aneroid barometer, and, having frequent means of testing our levels upon points the elevations of which were actually known, we may state with confidence that our aneroid's errors may be all found within a zone of 10 feet vertical thickness, quite near enough for a reconnaissance. The rest of our work was among the archives of Pennsylvania, and, as one or other of the corps had traced every foot of ground between Pittsburgh and Havre de Grace, we think we have been able to submit a practicable plan and a reliable estimate. The special works of the great line we have enumerated and estimated, but not located with precision, except vertically. It would take a very careful location survey to say exactly where each of the works should be placed. Had it not been for the archives, we could have only pronounced on the possibility of this grand enterprise. With their aid we can not only say that it is practicable, but we believe it could be let to-morrow and built at our estimate. Whether it would be worth the money is for the consideration of the people. Its capacity to transport would nearly reach, if not exceed, 10,000,000 tons per annum. Put it at 5,000,000 tons through trade, and one-quarter of a cent per ton per mile would pay 6 per cent. on a cost of \$40,000,000 and leave \$2,000,000 to pay for keeping up the work and its management, which would appear ample.*

And ought any work to pay more profit than that and do justice to the people in the matter of their transportation? A quarter of a cent per ton per mile, let that be called the inevitable first cost of transportation, leaving the other three-fourths of a cent to reward the transporters. To this complexion must we come at last. Our farmers, producers, merchants, ought all to be able to make their bargains when transportation was an element of the transaction, estimating transportation at the rate of one cent per ton per mile for everything; but as there must be exceptions to all rules, let there be exceptions here, slightly favoring, say, the heavy minerals, coal, iron, fire-clay, salt, stone, &c.

Attached to the estimate will be found a table of the reservoirs and their capacities. It will be seen that these are located on well-known water-courses; no dry ravines, but drains made in the mountain itself by nature, and of such a character in size as to have acquired a regular designation as a water-course of the country. These streams are never entirely dry; there is, in the greatest droughts, an appreciable amount of water in them. There can be no doubt on the subject of water in the minds of those who are aware of what has already been done in this way, and who know the wants of a canal, not perhaps in this country, but in Europe, particularly on the continent, where, for water-ways and for great manufacturing establishments, water has been studied and practiced with to an extent far beyond anything of the kind that has been even thought of among ourselves.

Before closing I must allude to my assistants in the field, Mr. W. H. Snyder, of Centre County, in command, and Mr. Charles A. Young, of Philadelphia, in charge of the levels and the aneroid. They both of them performed their parts well. Mr. H. Alricks, jr., of Harrisburgh, has assisted Mr. Snyder in the mapping, and, bearing in mind that they were obliged to derive much of their data from musty archives, they deserve credit for their research.

To gentlemen in Cambria and Blair Counties I am very much indebted for local topographical information; to Mr. Hutchinson, of Altoona; to Messrs. Fulton, Peeler, and Brawley, of the Cambria Iron Company; to Mr. Antes Snyder, of the Pennsylvania Railroad engineer corps; and to Captain Kelly, of Apollo, on the Kiskiminetas; also to Mr. Gibboney and Mr. Irvine, of Duncansville, Blair County; also to gentlemen of Hollidaysburg, namely, Judge Caldwell, Mr. Jack, and Mr. Gardner, and to Lawyer Hewit; but especially to Mr. D. K. Reamey, who was indefatigable in serving the little corps in every way that he could, both by his local knowledge, which is quite extensive, and acting as a guide in several cases to the mountain passes. I trust that the hopes of these gentlemen may at last be fulfilled, and that they may repossess one of our great lines of communication.

I am, very respectfully, your obedient servant,

JAMES WORRALL, C. E.,
Assistant.

Bvt. Col. W. E. MERRILL,
Corps of Engineers, U. S. A.

*The Erie Canal transported over 5,000,000 tons last year and did not cost \$1,000,000 to keep up—scarcely more than three-fourths of a million.

Estimate showing the cost of a water-line through Pennsylvania and part of Maryland, by way of the Allegheny, the Kiskiminetas, the Conemaugh, the Juniata Rivers, and the river Susquehanna, to Chesapeake Bay, at Havre de Grace, Maryland, the result of a reconnaissance made in the year 1878-79, under the charge of Bvt. Col. W. E. Merrill, U. S. Engineers, by James Worrall, assistant.

EASTERN DIVISION.

<i>First section.</i> —Havre de Grace to foot of Kanewago Falls:	
237,600 linear feet enlarged canal, at \$8	\$1,900,800
10,560 linear feet independent canal, at \$10	105,600
Dam and guard-lock at Chicques	300,000
60,440 linear feet towing-path, at \$2	120,880
251 vertical feet lockage, at \$2,500 per foot	652,500
Contingent works, bridges, &c	154,220
Amount	3,234,000
<i>Second section.</i> —Kanewago Falls to mouth of the Juniata:	
154,100 linear feet independent canal, at \$10	1,541,000
82 vertical feet lockage, at \$2,500	205,000
Dam, with guard-lock and feeder, at mouth Juniata	150,000
Contingent works, bridges, &c	95,000
Amount	1,991,000
<i>Third section.</i> —Mouth of Juniata to Frankstown:	
Slackwater navigation, 57 dams, at \$43,650 each	2,488,050
661,700 linear feet towing-path, at \$2 per foot	1,323,400
569 vertical feet lockage, at \$2,500 per foot	1,422,500
Contingent works, bridges, &c	261,050
Amount	5,495,000
<i>Summary.</i>	
First section	3,234,000
Second section	1,991,000
Third section	5,495,000
Total	10,720,000

MOUNTAIN DIVISION.

<i>First section.</i> —Frankstown to east end of tunnel:	
64,000 linear feet independent canal, at \$10	640,000
788 feet vertical lockage, at \$2,500	1,970,000
Contingent expenses, bridges, &c	150,000
Amount	2,760,000
<i>Second section.</i> —Tunnel, reservoirs, &c.:	
1,215,650 cubic yards tunneling, at \$5	6,078,250
Excavation, approaches	91,600
28,100 cubic yards brick arching, at \$10	281,000
One shaft, 10 feet diameter, 850 feet depth, at \$30	25,500
Contingent expenses	323,650
Amount	6,800,000

RESERVOIRS.

Yellow Creek: 451,000 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 40 acres, at \$150	\$178,850
South Fork: 498,000 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 130 acres, at \$150	208,800
Laurel Run: 590,000 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 250 acres, at \$150	259,000

Trout Run: 325,000 cubic yards bank, at 35 cents; outlet, \$25,000; by-wash, \$5,000; clearing 50 acres, at \$150	\$151,250
Sonman Run: 88,750 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 12 acres, at \$150	47,862
Ben's Creek: 380,000 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 34 acres, at \$150	153,100
Conemaugh: 68,500 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 30 acres, at \$150	43,475
Oak Run: 310,000 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 60 acres, at \$150	132,500
Munster Run: 404,000 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 134 acres, at \$150	176,500
Sugar Run: 337,000 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 20 acres, at \$150	135,950
Portage Creek: 80,000 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 10 acres, at \$150	44,500
Adams Creek: 290,000 cubic yards bank at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 16 acres, at \$150	118,900
Blair's Creek: 205,400 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 25 acres, at \$150	90,640
Poplar Run: 385,200 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 20 acres, at \$150	152,820
Knob Run: 280,000 cubic yards bank at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 30 acres, at \$150	117,500
Bull's Creek: 373,000 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 100 acres, at \$150	160,550
Bobb's Creek: 242,000 cubic yards bank, at 35 cents; outlet, \$12,500; by-wash, \$2,500; clearing 110 acres, at \$150	116,200
Contingent expenses	114,603

FEEDERS AND CONNECTIONS OF RESERVOIRS.

To east and west end of tunnel, 296,200 linear feet feeders, at \$2	\$592,400
5,300 linear feet pipe drift, at \$3.33 1/3	17,666
18,000 linear feet iron pipe, laid, at \$7.50 per foot	135,000
Clearing 570 acres, at \$150	85,500
Contingent expenses	41,434
Amount	872,000

MOUNTAIN DIVISION—Continued.

Third section.—West end of tunnel to Johnstown:

15,000 linear feet independent canal, at \$10	\$150,000
13,000 linear feet independent canal, at \$12	156,000
Slackwater, 35 dams, at \$20,000 each	700,000
600 linear feet tunnel, 26,000 cubic yards, at \$4	104,000
70,700 linear feet towing-path, at \$2	141,400
551 vertical feet lockage, at \$2,500	1,377,500
Contingent works, bridges, &c	143,100
Amount	2,772,000

Summary.

First section	\$2,760,000
Second section—tunnel	6,800,000
Reservoirs	2,403,000
Feeders	872,000
Third section	2,772,000

WESTERN DIVISION.

First section.—Johnstown to Blairsville:

Slackwater navigation in Conemaugh, 22 dams, at \$28,000 each	\$616,000
159,900 linear feet towing-path, at \$2 per foot	319,800
219 vertical feet lockage, at \$2,500 per foot	547,500
Contingent works, bridges, &c	74,200
Amount	1,557,500

Second section.—Blairsville to mouth Kiskiminetas:

Slackwater navigation, 19 dams, at \$40,000 each	\$760,000
230,800 linear feet towing-path, at \$2 per foot	461,600
188 vertical feet lockage, at \$2,500 per foot	470,000
Contingent works, bridges, &c	84,600
	1,776,200

Third section.—Mouth of Kiskiminetas to Pittsburgh:

Slackwater navigation, 4 dams, at \$160,000 each	640,000
153,200 linear feet towing-path, at \$2.50 per foot	383,000
42 vertical feet lockage, at \$2,500 per foot	105,000
Contingent works, bridges, &c	57,000

Summary.

First section	1,557,500
Second section	1,776,200
Third section	1,185,000

	Totals.	Lengths.
Eastern division	\$10,720,000	212 miles, 5,040 feet.
Mountain division	15,607,000	36 miles, 3,220 feet.
Western division	4,518,700	103 miles, 60 feet.
Total	30,845,700	352 miles, 3,040 feet.

LOCKAGE.

	Feet.
Chesapeake Bay to tunnel	1,700
Tunnel to Pittsburgh	1,000
Total	2,700

Statement of reservoirs.

Location.	Number of dams.	Height.	Capacity in cubic feet.
		Feet.	
Yellow Creek, west side	1	80	70,000,000
South Fork, west side	1	80	190,000,000
Laurel Run, west side	1	80	246,000,000
Trout Run, west side	2	50	53,000,000
Sonman Creek, west side	1	50	15,000,000
Ben's Creek, west side	1	100	62,000,000
Conemaugh, west side	1	45	23,000,000
Oak Run, west side	1	80	100,000,000
Munster Run, west side	1	80	195,000,000
Sugar Run, east side	1	100	29,000,000
Portage Creek, east side	1	50	11,000,000
Adam's Creek, east side	1	100	19,000,000
Blair's Creek, east side	1	80	27,000,000
Poplar Run, east side	1	90	27,000,000
Knob Run, east side	1	80	33,000,000
Bull's Creek, east side	1	80	80,000,000
Bobb's Creek, east side	1	60	77,000,000
	18		1,257,000,000

THE ESTIMATE.

It will be seen that the estimates of the different divisions amount to the sum of	\$30,845,700
Now, if we double the locks, we must add	5,400,000
Doubling a lock is not quite doubling its cost; we reduce the double 20 per cent	36,245,700
It is usual to add 10 per cent. for unforeseen contingencies	3,624,570
Making	39,870,270
We increase the sum by	129,730
Which makes the round sum	40,000,000

An amount deemed sufficient to make a water-way of 280 tons capacity per boat from Pittsburgh to the head of Chesapeake Bay, which sum has been used in the text of the report.

In like manner it will be seen that 352 miles + 3,040 feet, or 352½ miles + 400 feet, is given for the length of this work. This we have called in the body of the report 355 miles; for on a line dealing with meandering streams there may well be such a margin, and this provision, too, is on the safe side. So the line may be considered to be 355 miles long, and is estimated to cost \$40,000,000, calculating for double locks the whole way.

This estimate is reasonable, and, as we have said already, we believe the work could be let or contracted for to-morrow for that sum, and finished within the time necessary to complete the tunnel, which certainly could be done within five years.

All which is respectfully submitted with the foregoing report.

A map on a scale of about 8 miles to the inch; and a large map, showing the mountain division on a scale of 2,000 feet to the inch; the eastern and western divisions, on a scale of 10,000 feet to the inch, will accompany this report.

J. W., *Assistant.*

V 10.

SURVEY OF THE KENTUCKY RIVER AND ITS NAVIGABLE TRIBUTARIES.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 14, 1879.

GENERAL: I have the honor herewith to submit the report on the survey of the Kentucky River, ordered in the river and harbor act approved June 18, 1878.

As this survey had been inserted in the bill at the request of the Representative from the ninth district of Kentucky, I endeavored to comply with his wishes by directing the engineer in charge to give special attention to the tributaries that unite at Three Forks to form the Kentucky River. This course was evidently the most judicious, in view of the fact that from the Three Forks to its mouth the Kentucky had been surveyed by engineers in the service of the United States, and resurveyed by engineers in the service of the State of Kentucky, with a close agreement in the results.

It was evident that the only advantageous use that could be made of the limited sum allotted for the present survey was to extend former surveys up the chief tributaries. I had the good fortune to secure the services of Mr. R. H. Fitzhugh, as assistant engineer, to take charge of the survey, and was thus enabled to obtain a full report on the whole river, as he had recently made a thorough examination of the lower part of the river under the authority of the State of Kentucky, and by access to the maps and reports on file at the capital of the State, and in the office of the Chief of Engineers in Washington, was able to give reliable data on the section of the river lying between his present and his former surveys.

The following is a concise summary of the results of the information obtained from these various sources:

The Kentucky River, from its mouth to the mouth of Middle Fork, is 258 miles in length. In this distance the fall of the river surface is 228 feet, which is an average of 10½ inches per mile.

The lower 95 miles of the river was many years ago improved, at the expense of the State of Kentucky, by the construction of five locks and dams, with a total lift of 70 feet, being an average lift per lock of 14 feet. All of these structures are now in a dilapidated condition, and require extensive repairs.

It is estimated that twelve more locks and dams will be needed to carry slackwater to the Three Forks at the mouth of Middle Fork.

The estimate for improving the main Kentucky River from its mouth to Three Forks is as follows:

For repair of the five locks and dams now in the river.....	\$84,802
For twelve more locks and dams.....	989,600
Total.....	1,074,402

To continue the slackwater system up the North Fork to Brashear's salt-works, at the mouth of Leatherwood Creek, a distance of 121 miles, will require fourteen locks and dams, overcoming a rise of 204 feet, being an average lift of 14½ feet per lock. The approximate cost of this improvement will be \$1,386,000.

To continue the improvement of the North Fork from the mouth of Leatherwood Creek up to its headwaters, a distance of 44 miles, limiting the work to the removal of obstructions to rafting, will require an expenditure of about \$10,000. This includes the cost of removing several small mill-dams which now interfere with the natural use of the stream.

To continue the slackwater system up the Middle Fork from Three Forks to the crossing of the old Hazard and Manchester road in Leslie County, a distance of 68 miles, will require thirteen locks and dams, with a total lift of 169 feet, or an average lift of 13 feet. The approximate cost will be \$786,000.

To continue the slackwater system up the South Fork from Three Forks to the Goose Creek Salt Works, a distance of 69 miles, will require fourteen locks and dams, with an average lift of 15 feet, and the approximate cost of the work will be \$968,000.

Respectfully submitted.

WM. E. MERRILL,
Major of Engineers.

Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

REPORT OF MR. R. H. FITZHUGH, ASSISTANT ENGINEER.

FRANKFORT, KY., *January 1, 1879.*

SIR: The work of surveying the Kentucky River, for which I was employed by you in August last, has been prosecuted to the limit of the time and means allotted to this service, and with the aid of reports of old surveys made by the United States and the commonwealth of Kentucky, I am enabled to furnish all the information generally necessary to a satisfactory preliminary estimate of the cost of locking and damming the Kentucky River and main tributaries thereof, and to state with some approximation to accuracy the commercial value of such a work after it shall have been perfected.

The accompanying tables constitute an exhibit of the chief results of all the surveys which have ever been made by State or Federal Government from the year 1829 down to the present, and to their examination I respectfully ask your attention before proceeding to the further consideration of this report.

The work performed consists of the survey of the North Fork from Leatherwood Creek to Pound Gap, 45 miles; 7 miles of Boone Fork; 4 miles of Troublesome Creek; 36½ miles of Middle Fork, from Crockettsville down to its mouth; 3½ miles of the North Fork, from the mouth of Middle Fork to Beattyville; 12½ miles of the South Fork, from its mouth at Beattyville to the village of Booneville, the county seat of Owsley County; and a boat reconnaissance of the main stream from Beattyville to Frankfort; including all necessary measurements of water discharge, width of channel, height of banks, &c., all of which information in its more detailed character is set forth in the tables, profiles, and maps herewith transmitted. The tables are arranged so as to exhibit, in sections, the important result of all the surveys that have ever been made on the Kentucky River, as well as estimates of cost for improving the same. Table A relates to the main stream from its mouth to the mouth of Middle Fork. Table B embraces that portion of the North Fork included between the mouth of the Middle Fork and Leatherwood Creek. Table C contains an estimate of the cost of clearing the North Fork of

obstructions from Leatherwood to Boone Fork. Table D exhibits all information pertaining to the improvement of the Middle Fork. Tables E and F relate respectively to the South Fork and the Cumberland River connection. Table G is an exhibit of water discharges. Table H contains the results of investigations into the question of hydraulic limestones.

In the determination of the question affecting the magnitude of the work to be done, I have been governed by the principle that whether an object is worthy of accomplishment or not depends upon its probable value after it shall have been accomplished; and in fixing upon a general plan which should constitute a safe basis for estimates of cost, I have been chiefly influenced by the results of actual experiment upon the Kentucky River, covering a period of forty years or more. Upon this basis, with such modifications as the changed circumstances of condition and economy suggest, I have the honor to report in favor of the establishment of slackwater on the plan at present existing on the lower section of the river proper:

1st. From the mouth of the river to the mouth of Leatherwood on the main stream, being a distance of 378.8 miles.

2d. On the Middle Fork, from its mouth to the crossing of the old Hazard and Manchester road, a distance of 68 miles.

3d. On the South Fork, from its mouth at Beattyville to the Goose Creek Salt Works, near the mouth of Collins Fork, a distance of 68.5 miles.

Above the mouth of Leatherwood to Whitesburg, and still farther up, to the junction of Boone Fork, the rise is too great and the river too crooked and narrow to justify the erection of locks and dams for continuous navigation. I have, therefore, submitted an estimate only for the removal of obstructions from this portion of the river. But there are large and valuable interests of coal and timber to be reached by the improvement of this section, and if some better method were adopted—such, for instance, as storage dams, affording periodic navigation—it would amply repay all the outlay necessary to its accomplishment. Of the practical working, however, of this system I am but poorly advised, and in this matter gladly defer to your own more cultivated and mature judgment.

In the execution of my purpose to lay before you all reliable and valuable information pertaining to the question under discussion that has ever, at any time, been obtained, I present herewith a tabulated statement of the characteristics and estimated cost of the time-honored project of connecting by canal the waters of the Cumberland with the proposed slackwater improvement of the Kentucky River. The details of this project were worked up about forty-three years ago by R. P. Baker, and the following statements are condensed from his reports on this water-line.

The commercial significance of such a link consists chiefly in the very considerable enlargement of the coal and timber area thus brought near to market, and in its being another step toward the accomplishment of that grand old purpose of connecting the Ohio Valley with the South Atlantic coast by means of this improvement, piercing the mountains at Cumberland Gap with a tunnel less than three-quarters of a mile in length, continued along the waters of the Tennessee, and thence, by canal, connecting with the waters of the Savannah River at the head of steamboat navigation.

In his report of 1835, Mr. Baker, then State engineer of Kentucky, says: "I feel gratified that I am enabled to state my conviction that an abundant supply of water can be commanded at Cumberland Gap from a level considerably elevated above the plane of the requisite works, and of the most easy and convenient access. The means of passing Cumberland Gap are offered by the construction of a tunnel of probably not exceeding seven to eight hundred yards in length. Having perforated the Cumberland Mountains, an open plane, 5 miles down the valley of a creek, would lead the improvement into Powell's River, a bold and copious tributary of the Tennessee, whence it could be continued by locks and dams down that river, and thence by canal to Georgia."

The value of this authority is somewhat enhanced by a knowledge of the fact that for many years prior to the date of this report he had been professionally engaged on the Muscle Shoals Canal in Alabama, and subsequently in charge of the improvements then being constructed by the State of Tennessee in the Holston and Tennessee Rivers between Knoxville and the Alabama State line. In adverting to some of the advantages of such a line of improvement, the same writer says:

"The canal would outflank the whole chain of Appalachian Mountains on the southwest; and in the course of its extent, it would cross the various noble rivers, Coosa, Chattahoochee, Oconee, &c., which, taking their rise in the chain of the Appalachians, flow into the Gulf of Mexico and into the Atlantic Ocean between the cities of New Orleans and Charleston; thus throwing open to the commerce of the countries bordering on the Ohio a choice among the numerous and greedy markets presented by the vast extent of cotton country along the southwestern coast of the United States, independently of the facilities it would offer for reaching the northeastern cities or European ports through the ports of Savannah and Charleston." "Certainly, in this view of the case, the improvement of the Kentucky River is in-

vested with a national importance, which entitles it to some measure of the consideration usually accorded the great commercial lines of the country.

By reference to the accompanying tables, you will find that the aggregate cost of the work actually recommended to be done is estimated at \$4,223,412, apportioned as follows:

For the Kentucky River proper, from its mouth to the mouth of the Middle Fork, a distance of 257.5 miles, \$1,074,402.

For the North Fork, from the mouth of the Middle Fork to the mouth of Leatherwood Creek, a distance of 121.3 miles, \$1,336,000; thence continuing up the North Fork from the mouth of Leatherwood Creek to the mouth of Boone Fork, a distance of 38.2 miles, \$9,010.

For the South Fork, from its mouth to Goose Creek Salt Works, a distance of 68.5 miles, \$968,000.

For the Middle Fork, from its mouth to the crossing of the Hazard and Manchester road, a distance of 68 miles, \$786,000.

The aggregate length of slackwater navigation thus obtained amounts to 553.5 miles, without considering that which consequentially ensues upon the various smaller tributaries and creeks; in relation to which, however, I have not the data necessary to the formation of an estimate of any approximate correctness. Dismissing from the discussion of this question its influence upon the welfare of the commonwealth at large, as well as its relation to the commercial interests of the whole country, it is believed that there will still remain a degree of force in the argument that 4,000 square miles of coal and timber will thus be rescued from a state of uselessness and committed to the waiting hands of thousands who now endure the pangs of involuntary idleness; these considerations should suffice to dispel the doubts of the most incredulous concerning the economic wisdom of investing \$4,000,000 in its complete accomplishment.

Although on the upper portions of the tributaries embraced in the proposed plan of improvement there would not be a continuous navigation through the dry season, yet it is manifest that they can so adapt the method of conducting their business to the character of their facilities of transportation that the amount of annual tonnage would be nearly as great, and the industrial activities imparted almost as considerable, as if there was no interruption in the navigation of the river.

In order to a just comprehension of the latent wealth of this valley, which would be developed by the proposed improvement, I beg leave to quote from a higher authority, one whose opinion derives paramount weight from a fitness of high order for many years exclusively devoted to the determination of this and kindred questions. I refer to the geologist of the State, Prof. N. S. Shaler, from whose "General Account of the Commonwealth of Kentucky," published in 1876, I extract as follows:

"Sixty miles below the Licking the Kentucky discharges into the Ohio. This stream is the second of the Kentucky streams in volume and the first in length. Its headwaters, from Sturgeon Creek east, lie altogether within the coal-bearing rocks. The coal holds along the hill-sides as far as Station Camp Creek. The upper half of the Red River Branch contains also an abundance of coal. The entire drainage of the Kentucky River, above its forks in Lee County, is in the Carboniferous rocks. No portion of the State exceeds the Upper Kentucky region in number, thickness, or quality of coals. A preliminary section, made by Mr. P. N. Moore, of the Kentucky Geological Survey, from Red River, in Wolfe County, to the mouth of Troublesome Creek, in Breathitt County, establishes the fact that up to the latter point there are at least five workable coal seams above the conglomerate sandstone.

"The following analyses, from carefully averaged samples, will show the excellent quality of the coals:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Specific gravity	1.300	1.294	1.297	1.290	1.289
Moisture	2.50	3.50	3.56	2.76	2.10
Volatile combustible matter	41.10	35.20	33.56	36.60	36.20
Fixed carbon	49.22	56.70	58.33	56.50	58.20
Ash	7.18	4.60	4.50	4.06	3.50
Coke	56.40	61.30	62.88	60.56	61.70
Sulphur	0.818	1.189	1.381	0.865	0.836

"No. 1 is from Frozen Creek, Breathitt County.

"No. 2 is 5 feet 7 inches thick, and comes from Devil Creek, Wolfe County.

"No. 3 is from Spencer's Bank, Breathitt County.

"No. 4 is 6 feet thick, and comes from Wolfe Creek, Breathitt County.

"No. 5 is from a point near Hazard, Perry County.
"Analyses by Dr. Robert Peter and Mr. John H. Talbatt, chemists for the Kentucky Geological Survey."

"The cannel coal of the Upper Kentucky is to be found over an extensive area, and is of a remarkably good quality, as will be seen from the following analyses by the chemists of the survey, made from average samples:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Specific gravity	1.280	1.265	1.280	1.180
Moisture	0.94	1.30	3.40	1.20	1.20
Volatile combustible matter	52.38	47.00	34.40	58.80	40.86
Fixed carbon	35.54	44.40	46.96	35.30	46.44
Ash	11.14	7.30	6.24	4.70	9.50
Coke	46.68	51.70	53.20	40.00	57.94
Sulphur	1.423	1.574	0.630	No test.	0.634

"No. 1. George's Branch cannel coal, Breathitt County.
"No. 2. Haddock's cannel coal, mouth of Troublesome Creek, Breathitt County.
"No. 3. Robert's coal, Perry County.
"No. 4. Frozen Creek, Breathitt County.
"No. 5. Salt Creek, Perry County.
"Three of the best gas coals in Scotland and England are (No. 1) Lesmahago cannel, (No. 2) Ramsey's Newcastle coal, (No. 3) Weym's cannel coal. Compare with the above the following analyses taken from Dr. Peter's Report, Vol. II, first series, Kentucky Geological Survey:

	No. 1.	No. 2.	No. 3.
Specific gravity	1.228	1.29	1.1831
Volatile matter	49.6	36.8	58.52
Fixed carbon	41.3	56.6	25.28
Ash	9.1	6.6	14.25
	100	100	98.45

"In addition to the numerous workable coals above the conglomerate sandstone in this region there are two workable coals below the conglomerate. The excellent quality of these coals can be seen from the analysis No. 1601, p. 81. Just below the coal the Carboniferous limestone bears upon its top the ore known as the Red River iron ore, which has long furnished a very celebrated cold-blast charcoal iron, well known as Red River car-wheel iron. There is probably about 100 miles of outcrop of this ore within a short distance of the tributaries of the river and within 20 miles of the main stream. Salt, fire-clay, and hydraulic cement abound in the black shale and Upper Silurian rocks. From Burning Creek to the mouth the Kentucky Valley runs entirely within the Upper Cambrian or blue limestone.

"The soils in this valley have the same character as in the Licking, ranging from the light loamy soils of the Carboniferous, through the clays of the Silurian and Devonian, to the exceedingly rich blue grass soils of the Cambrian and Cincinnati limestone rocks. The navigation of the Kentucky River has been improved by locks and dams as far up as a point about 25 miles above Frankfort. The stream is admirably adapted for the extension of this method of navigation until over 600 miles of navigable water is secured. As in the case of the Licking and the Green, it has the peculiar advantage of having a very great variety of soil and natural products within a narrow compass.

"The timber resources of the part of this valley that lies within the coal-bearing area are very great; all the important timber trees of Kentucky, except the cypress, are found within the valley. The black walnut is found in abundance on the hillsides throughout this section, the finer qualities of oak, much yellow pine, some white pine," &c.

But beyond the limit of Professor Shaler's investigation, even as far up as the source of the river, and embracing the utmost limits of its tributary system, this coal field extends in the same richness and variety, cropping out on the one hand or the other at almost every step of one's progress along the valley. A large number of the strata

can be reached by simple drifts into the hillsides, being what miners term "level free," thus inviting to easy and profitable development.

In order of importance the improvement of the North Fork would seem to rank first, as being the richest in resources of both timber and coal, as favorably affecting the largest area of territory, conducing to the welfare of the greatest number of people, and as constituting an important link in probable future railroad and water-line of communication between the seaboard of Virginia and the city of Louisville. This route could be opened to Abingdon, where it would connect with the Virginia system, by the construction of 75 miles of railroad after the completion of the proposed slack-water navigation of the Kentucky River.

The relative importance of improving either the South or the Middle Fork is so nearly equal that I am left without any sufficient reason for giving the preference to either. The extent and native wealth of the sections to be developed are well balanced, and while the improvement of the South Fork may in time constitute a portion of a more extended line of communication, on the other hand the improvement of the Middle Fork would at less cost afford a market for remarkably rich stores of cannel coal and timber. The construction of a canal connecting the waters of the Kentucky with the waters of the Cumberland would give access to another great field of coal, but in addition it would open up a walnut forest of unusual magnitude and value; and as the present and growing demand for this timber, at home and abroad, coupled with its alarmingly rapid destruction, invests with peculiar interest any report of new supplies of this valuable product, and clothes with magnified importance any project looking to its attainment and utilization, I, therefore, beg leave to copy from a report upon the timber of this section made by Lafayette H. De Friese, esq., to Prof. N. S. Shaler, in March, 1877. Mr. De Friese says:

"I deem it best, before commencing the more minute consideration of the effect of different soils, height above drainage, &c., upon different timbers, to refer generally to some peculiarities that struck me in the distribution and growth of certain varieties of trees. As black walnut is the most valuable of the timbers, I shall commence with that. I made a section across Black Mountain, starting on the Cumberland River at Hezekiah Hall's, not far from the dividing line between Bell and Harlan Counties. My barometer at the starting point stood 1,870. At a height of about 1,300 barometric feet above the datum point, and about 500 barometric feet below the crest of the mountain, I found a remarkable belt of the finest old forest walnut timber that I have ever seen. The trees are more scattering now in this belt than they have been, for the trunks of several of the finest, which had fallen during the year, were still lying there. This walnut-growing belt winds along the mountain as far as I had time to trace it (which was not very far, however), always at about the same height above the river below. I noticed that it was just under the top crest of the mountain, and crossed precisely at the heads of the various little streams that flowed from under that crest and made their way to the river below. One of the many magnificent walnut trees that I found in this peculiar belt was 14 feet and 6 inches in circumference, with a curling but straight and beautiful trunk 60 feet in length. In an area of 1,250 square yards in this belt the principal timbers were: Black walnut, 6; average diameter, 40 inches. Buckeye, 5; average diameter, 29 inches. White ash, 3; one of them with a diameter 34 inches. Linden ash, 6; average diameter, 23 inches. But this plat of ground was a choice one. There is not such an average of walnut as that, even in the belt here spoken of.

"The walnut timber is as ruthlessly destroyed in Eastern as in Western Kentucky. I saw a magnificent walnut tree, 40 inches in-diameter, with a trunk of more than 50 feet in length, cut for rails; a tree worth hundreds of dollars sacrificed for a few panels of fence. No care whatever is taken either to preserve the old forest walnut now standing, or to encourage the young growth."

My own observations of the timber along the Kentucky River and its tributaries have been very considerable, and in some degree critical. At various times in the past six years I have been occupied in river and railroad surveys and reconnaissances along this valley and across it on various lines, some extending to and across the valley of the Cumberland, and I have found, everywhere, a very superior growth of white oak, much of it with long, clear bodies, fitting it admirably for the manufacture of pipe and other staves of high value in foreign markets. Poplar timber of an excellent quality, while not so abundant as white oak, is quite generally distributed. On the headwaters of the Kentucky River I particularly observed poplar and white oak of enormous size and height, and of astonishing frequency, exciting in my mind a sense of profound wonder at the strength of the soil obviously necessary to its production. On the Red River only is there a large area of white pine. Everywhere on the higher levels in the coal regions yellow pine grows in abundance, much interspersed with fruit-bearing chestnuts; and over a large territory, constituting the common source of the waters of Station-Camp, Ross, Buck, and Sturgeon creeks, I have observed a remarkably fine stand of yellow pine, in association with a beautiful and thrifty growth of poplar and white oak. A goodly variety of well-developed hickory is a universal