Money statement.

July 1, 1878, amount available	$91,604 93	
Amount of sales, &c	19 26	
Amount appropriated by act approved March 3, 1879	20,000 00	
		$111,624 19
July 1, 1879, amount expended during fiscal year	73,920 79	
July 1, 1879, outstanding liabilities	3,007 84	
		76,928 63
July 1, 1879, amount available		34,695 56
Amount that can be profitably expended in fiscal year ending June 30, 1881		175,000 00

W 2.

IMPROVEMENT OF WHITE RIVER, INDIANA.

By letter of the Chief of Engineers, of April 5, 1879, I was informed that an appropriation of $25,000 had been made for "improving White River, Indiana, from the Wabash River to Portersville, and to the falls on the West Fork, according to report of the Chief of Engineers, without constructing locks and dams."

In accordance with request in the same letter, I submitted a project to apply the amount as follows:

As the appropriation is too small to justify any extensive works, I proposed to expend it on such parts of the improvement as could be done to best advantage. This was—

1. The purchase of apparatus and removal of snags.
2. The deepening of the channel where bars occur, contracting its width with jetties, wing-dams, or dikes.

At the season of the year when navigation on this river would be a vast benefit to a large section of country, the water is low and so much obstructed, principally by snags and sand bars, that it is not practicable for boats to run.

In my report of December 31, 1878, of examinations made on this river, I gave a few indications of its commercial importance. It is the natural outlet to a wonderfully productive portion of the State, and the improvements contemplated cannot fail to result in benefits far exceeding their cost.

* * * * * * *

The estimate for the entire work submitted with my report of December 31, 1878, was $150,000.

During the year ending June 30, 1881, I would recommend the completion of improvement at Kelly's Ripple.

To continue removal of snags and deepening channel at various bars, and making rock excavations at various shallow places, detailed surveys should be made to determine more fully the nature and extent of the works required.

It will be an economy to the work and an advantage to the commercial interests to do the work as rapidly as possible, and I would therefore recommend that an appropriation of $75,000 be made for the ensuing year. I append a statement of funds appropriated and required:

Money statement.

Amount appropriated by act approved March 3, 1879	$25,000 00
July 1, 1879, amount available	25,000 00
Amount (estimated) required for completion of existing project	125,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1881	75,000 00

W 3.

EXAMINATION OF THE KANKAKEE RIVER, ILLINOIS AND INDIANA.

* * * * * * *

In 1847 a company was incorporated under the laws of the State of Illinois, under the name of the "Kankakee and Iroquois Navigation and Manufacturing Company"; the purposes and objects of said company being the "improvement of the navigation of the Kankakee and Iroquois Rivers, the erection of water-power on said streams, and the building and erecting mills and machinery of all kinds on and near said streams."

A subsequent act changed the name of the company to "The Kankakee Company." This company has acquired various rights and franchises from the State of Illinois, accompanied by certain limitations.

Through courtesy of officers of the Kankakee Company, and especially of Mr. E. S. Waters, its chief engineer, copies of the company's maps of the river in Illinois were obtained, together with a statement of levels and estimates for the cost of the necessary improvements.

* * * * * * *

The works completed by the Kankakee Company connect with the Illinois and Michigan Canal by utilizing the Kankakee feeder of that canal a length of little more than 4 miles.

The feeder and dam for its supply were constructed by the State of Illinois.

* * * * * * *

During the past six years but little if any progress seems to have been made by the Kankakee Company in prosecuting its improvements.

* * * * * * *

The improvements thus far have unquestionably been of great benefit to the adjacent sections, not only in the great reduction in the price of carrying supplies along its route, but in checking the tendency of railroads to take advantage of people's necessities by unjust discriminations in local freights to points where there are no competing lines.

* * * * * * *

There can be little doubt that the completion of improvements to render the river navigable to Momence would effect a saving in freight.

* * * * * * *

In the absence of any complete designs for the works needed to bring the navigation as far as Momence, I take the liberty of referring to the report of Mr. James Worrall, civil engineer, to a Board of Engineers, consisting of Bvt. Maj. Gen. J. H. Wilson, U. S. A., and Mr. William Gooding, United States civil engineer.

The following extract from this report, made in 1867 (see report of the Secretary of War, 1868, pages 466 and 467), is conclusive as to the practicability of the work, and, besides referring to its utility, gives in general terms an estimate of the entire cost:

> A regular survey was made from Blue Island to Momence, on the Kankakee, and from Momence to the junction of the Kankakee and the Des Plaines, where the Illinois River is formed. A reconnaissance was made of the Upper Kankakee from Momence, in a northerly direction, along the river well into the State of Indiana, say about 30 miles, among the Kankakee marshes, where boats had to be used, there being no footholding for the instruments.
>
> This survey and reconnoitering, although settling the point forever that there is no practicable outlet from Lake Michigan to the Mississippi waters except the one chosen and reported upon, nevertheless gave rise to suggestions more or less pregnant and important.

It is very certain that a navigation of respectable size can be made from this work at or near the mouth of Kankakee to Momence, thus developing a rich and productive section of the country for a distance of nearly 50 miles, and it is not at all certain but that this navigation can be extended and produced among those Kankakee marshes for a hundred or more miles further, until indeed a junction can be effected with the Wabash and Erie Canal, thus producing a smaller canal, but one capable of transporting, say, a million or more tons per annum to Lake Erie.

I can pronounce with great certainty in favor of the practicability of the work as far as Momence. Its possibilities beyond are only suggested, and cannot be realized without a more careful investigation of that interesting region.

A clearing out and unification of channels, and an occasional cut-off, will give a small steamer navigation on a minimum depth of, say, 2 feet for 100 miles northward of Momence even as it is. A judicious expenditure of, say, a quarter of a million would no doubt effect this, and at the same time assist materially in draining that noble body of land, and I hint at the possibility of a 4-foot navigation being constructed through that region, which, as has been stated, may be attached to the Maumee work, thus connecting the Mississippi by water with Lake Erie in a direction favorable to cheap transportation, an immense saving in distance being made as against the passage by the lakes to the same point.

The work from the mouth of the Kankakee to Momence, 47½ miles, can be constructed for $950,000, being at the rate of $20,000 per mile; this for a slackwater navigation, with locks 100×17×5 feet deep, capable of passing boats of, say, 125 tons. The fall from Momence to the Kankakee feeder is 105 feet, and a gauge of the stream at its mouth, on the 9th of September, 1867, an extraordinarily dry period, gave 27,377 cubic feet per minute, including the amount passing through the feeder to the Illinois and Michigan Canal. It is proper to say here that the limestone, much pervaded by fissures, over which the Kankakee flows, near its mouth, may considerably reduce the visible quantity of water flowing over it; that therefore its contribution to the Illinois may be larger than appears from the gauge, and 30,000 feet per minute may fairly be taken as the minimum of the past season.

About 21 miles of the work indicated in this extract has already been completed. In 1873 Mr. Waters, whose intimate acquaintance with the work would enable him to judge, estimated the cost of improving the remaining portion to Momence at $326,000.

In undertaking a work of this kind it is well to look to the future requirements regarding the size of boats which may be desirable. I should recommend the construction of locks of greater capacity than those indicated, especially in the width, as it seems that 17½ feet is too small a limit to place upon the width of boats engaged in river navigation.

The work, if done, will require additional surveys, and probably other contingent expenses, and I therefore estimate the expense of carrying the navigation from its present limit to the State line at $350,000, or less than $13,500 to the mile.

Whether the Kankakee Company would surrender its rights and franchises to the United States without compensation I am unable definitely to state.

Of the character of the Kankakee River in Indiana I can best give an idea from an account of my personal observation.

During a period of extreme low-water, from the 19th to the 22d of September last, through the courtesy of citizens of Momence and Kankakee, Ill., a small flat-bottomed steamer was obtained at Momence for the purpose of making a reconnaissance of the river above that place. The steamer had a stern wheel, and I give its dimensions from memory as about 75 feet long over all, 13 feet wide, and a draught of water not exceeding 1½ feet. A considerable party of citizens accompanied me up the river a distance of about 120 miles to a crossing known as Baum's bridge, shown on small map as Eaton's bridge, where the low roadway and absence of a draw prevented any further progress. The only obstacle worth a mention seen during the entire distance was a tree which had fallen into the channel in such a manner as to catch several snags and thus form a barrier. A single axe soon made an opening, and the steamer passed on from that point to Baum's bridge, a distance

of 15 miles, after it was so dark that the channel of the river could only be seen by throwing with reflectors a strong light upon the water ahead and the adjacent banks. Notwithstanding this, and the fact that not a man on board had ever before been over that portion of the river, and none of the party were boatmen, but simply citizens interested in showing the character of the river, no interruption occurred in the entire 15 miles.

The river is very crooked, and the worst obstacles at present are the numerous sharp bends where snags generally add to the other difficulties of passing.

These bends can be straightened, at a comparatively small expense, sufficiently to make boating easy and safe without diminishing the length of the river enough to add materially to its declivity and rapidity of flow.

The current has a velocity, as nearly as the means at hand enabled me to judge, of about 1½ miles per hour, and is sensibly uniform. There are no ripples or falls, and the only places where the velocity of flow is increased are where small bars, snags, or diminished width contracts the cross-section.

The water is very clear, so that the fish swimming about as the steamer passes, as well as minute objects on the bottom in a depth of 5 feet, can be seen distinctly.

The greater portion of the distance of 120 miles which I thus went over had a depth of 5 or more feet, and I found no case where it was less than 2 feet deep in the channel, and but very few as small as 3 feet.

Above the State line the river has a fall which is practically uniform for nearly 250 miles, the average fall being a trifle less than 4 inches to the mile. From the vicinity of the State line to Momence the fall of the water surface is somewhat greater. For a complete statement of the levels and flow of this portion of the river I would refer to the report of Mr. Ensign Bennett, a copy of which is with this report; and for a further description of the river above, I would refer to the letter of Father Joseph A. Stephan, included in Maj. G. L. Gillespie's report of "An examination for a route for a canal from Lake Michigan to the Wabash River, Indiana." (See Report of Chief of Engineers, 1876, Part II, page 461.)

The marshy lands bordering the Kankakee in Indiana are being rapidly reclaimed, and during the past season I have seen fine crops of corn and other produce where 10 years ago I am credibly informed a man could scarcely wade through the swamp.

There seems to be no doubt that the removal of obstructions in the upper portion of the river will aid considerably in the drainage of a large and valuable area, besides an immense benefit in the reduced freights and increased business which it will bring.

The rocky bed of the river at and near Momence has been considered a great obstacle to the drainage of the lands in Indiana. The fact that the fall above this place for several miles is considerably greater than the average, with a study of the general character of the river, leads me to believe that its removal would accomplish little or nothing for the drainage of lands so far above, while it could hardly fail to increase the expense of making that portion navigable.

In 1869 a company was organized under laws passed by the general assembly of the State of Indiana, under the name of the Kankakee Valley Draining Company. Under the direction of this company expensive surveys were made, and I am indebted to Father J. A. Stephan, who was employed on those surveys, for copies of a portion of the field-notes and for a topographical map of the river in Indiana. A tracing

of this map will be forwarded as soon as I can have it completed. A small map of the valley of the Kankakee, showing the work projected by the drainage company, is appended hereto.

Besides the examinations before mentioned, a small party in skiffs completed the reconnaissance. The river above Baum's bridge has a more crooked channel than the part I have described.

One of the roadway bridges across the river is constructed with a draw. All the other bridges are without draws, and are too low to permit of steamers, or any boats with housed decks, to pass under them.

Any through navigation above Baum's (or Eaton's) bridge will necessitate the introduction of draw-spans in the bridges.

The cost of improving the Kankakee River in Indiana will be comparatively small. The estimate is placed at $150,000 for improving a portion of about 150 miles in length.

The system to be pursued in these improvements would have in view simply a deepening, and, to a small extent, straightening the channel. To deepen the channel will require: 1st. The removal of snags. 2d. The removal of bars. The bars will disappear to a considerable extent by the removal of snags around which they have formed; those then remaining can be readily cut away by increasing the velocity of the current, through the agency of wing-dams and similar expedients. There being no perceptible amount of earthy matter held in suspension by the water at any stage, little or no difficulty need be anticipated in the removal of all bars without the formation of new ones. 3d. The unification of the channel. In many places portions of the water leave the main river through sloughs or bayous, and in some places islands divide the channel. These evils can be readily remedied by the use of cheaply constructed works of piles and brush.

In straightening the bends two cases will arise:

1st. Where a large bow exists, forming a peninsula with a narrow neck, it may be found desirable to shorten the channel by cutting across the neck of land. This would only be desirable where the shortened distance would not too greatly increase the declivity. In most cases the distance from side to side is very short, and a single cut of a dredge would be all the opening required for the water to perfect the work.

2d. Where bends are so sharp that they cannot be readily navigated, the point within the bend may be cut with a dredge, and by wing-dams or bank protections on the opposite side the necessary results can be accomplished at a small expense. In some places the action of the water is constantly cutting the banks, and besides otherwise injuring the channel is adding to its supply of snags. Any system of improvement looking to permanence should check this cutting by a proper protection of the exposed banks.

I would make the estimate as follows:

FOR IMPROVING KANKAKEE RIVER IN INDIANA.

Removal of snags	$50,000
Dredging	66,000
Brush and pile work	24,000
Engineering contingencies	10,000
Total	150,000

The above being at the rate of $1,000 per mile.

Respectfully submitted.

JARED A. SMITH,
Major of Engineers.

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

COMMERCIAL STATISTICS.

MOMENCE, ILL., *November* 11, 1878.

SIR: Inclosed find receipts of lumber of Eagle & Watson, the only general lumber dealers in town. In addition to these figures there has been for the last five years an annual average of a trifle over 33 car-loads shipped to private parties, the car-loads being about 6,000 feet each.

During the last year there has been 507 car-loads of grain and 104 car-loads of hay shipped from Momence, and 150 car-loads of soft coal and 43 of hard coal shipped to Momence.

There is now at least 1,000 tons of hay (100 car-loads) of the last year's crop on hand, waiting a market that will warrant a shipment.

With the exception of the shipment of stone, which is now in its infancy, and of cattle and hogs, which I think would never be made by water, I think the above comprise the main shipments to and from this place by freight, the merchants generally having their wares expressed.

Yours, truly,

J. L. CLARK.

Maj. J. A. SMITH.

Receipts of lumber, laths, shingles, doors, and sash by Eagle & Watson, Momence, Ill.

	Lumber.	Lath.	Shingles.	Doors.	Sash.
	Feet.	*Number.*	*Number.*	*Number.*	*Number.*
August 13, 1874, to February 29, 1875	1,874,884	146,000	513,750	233	4,713
February 29, 1875, to March 13, 1876	1,524,433	179,000	643,500	245	4,345
From March 13, 1876, to April 1, 1877	1,731,402	207,100	772,750	233	4,201
From April 1, 1877, to April 1, 1878	1,646,332	132,200	643,500	152	2,850
Total for about 3¾ years	6,777,051	665,300	2,573,500	863	16,109
Approximate yearly average	1,807,200	177,400	686,200	230	4,295

REPORT OF MR. ENSIGN BENNETT, CIVIL ENGINEER, TO THE KANKAKEE VALLEY DRAINAGE COMPANY.

MICHIGAN CITY, IND., *March* 30, 1872.

GENTLEMEN: Agreeably to your request, I have made some examinations of that portion of the Kankakee River extending from the State line of Indiana to the village of Momence, in the State of Illinois, a distance of about 7 miles. I reached Momence on the evening of December 10, 1871, and was joined by the Rev. J. A. Stephan and John Miller, esq., civil engineer, and on the morning of the 13th instant following by William C. Richards, esq., chief engineer of the Plymouth, Kankakee and Pacific Railroad, and by the aid of these engineers I am able to lay before you the following statement of facts derived from our survey:

We commenced our levels about 1,000 linear feet below the lower dam at Momence, and found a rise of 2 feet in the surface of the water in the river immediately below the dam.

The crest of the lower dam in the center was found to be 5.8 feet above the surface of the water at its foot. The surface of the water on the upper side of the dam was 8 inches below the crest, caused probably by the mills being in operation at the time. Continuing our levels to the State line, we found a total rise of 3 feet and 6 inches in the surface of the water from the upper side of the lower dam. These levels were taken on the 12th and 13th of December, when the water in the river was probably at its ordinary low stage. Comparing the ordinary high-water mark at the State line, as distinctly marked by discoloration on a white-ash tree, we found the elevation to be 5 feet and 10 inches above the surface of the water in the river.

Returning to Momence, an observation above the lower dam showed the ordinary high-water mark to be about 10 inches above the crest of the dam, or 1 foot and 6 inches above the surface of the water at that date; thereby giving at the ordinary high stage of water a surface fall between the State line and the lower dam of about 7 feet and 10 inches (actual 7.83 feet).

At the foot of the dam the ordinary high-water mark was found to be about 5 feet below the ordinary high-water mark above the dam.

I am informed that the mill-owners have a charter from the legislature of Illinois permitting them to maintain a dam 4 feet in height.

Assuming that this 4 feet is intended to be measured from the surface of the ordinary low stage of water, and not from the bed of the river, it will be observed that the crest is now 1 foot and 10 inches (actual 1.8 feet) higher than is allowed by law.

Further examinations were prosecuted by Messrs. Richards and Stephan, as I was unable through sickness to render any further practical assistance in the field. These engineers report that they extended the line of levels one-half of a mile above the State line, and found a rise in that distance of $5\frac{3}{4}$ inches in the surface of the water in the river. They also took a cross-section of the river at the State line, which has a sectional area of 543 feet, with a hydraulic mean depth of $4\frac{1}{2}$ feet; this giving the water a velocity of nearly 2.35 feet per second, with a flow of about 1,271 cubic feet per second.

Their next cross-section was taken about 1 mile above Momence, where it is supposed the greatest rock obstruction exists. This section had a wetted perimeter of 420 feet, with a sectional area of 1,026 feet, and the water a velocity of 1.4244 feet, thereby passing 1,457 cubic feet per second.

I understand that it is your intention to construct a ditch in the State of Indiana 42 feet wide on the bottom, 52 feet on the top, and 10 feet in depth, containing an area or cross-section of 470 feet, with an inclination on the bottom of 12 inches to the mile.

Such a ditch when running full of water will give a flow of $1{,}558\frac{1}{2}$ cubic feet of water per second, having a velocity of 3.3166 feet per second. As before stated, the amount of water delivered by the present channel is 1,271 cubic feet per second; it therefore follows that you cannot in any case deliver more than $287\frac{1}{2}$ cubic feet per second at the State line by the construction of your proposed ditch, as this would be its entire capacity ($1271+287\frac{1}{2}=1558\frac{1}{2}$) cubic feet of water. Messrs. Richards and Stephan give the width of the present channel at the State line as being 180 feet, with about the same fall to the first half mile that you propose to give to your ditch, while the latter has only a width of 52 feet on the top.

Practically, this would give but a very slight rise in the water at that point, unworthy in fact of consideration in a proposed work of this character.

Taking the amount of water arriving at the State line by the present channel of the river at 1,271 cubic feet per second, would give a depth of 8.2 feet of water in your ditch when constructed.

But it is to be presumed that your ditch will carry off the water with so much more rapidity than the old channel that its lower portion at least will run with full banks.

From the foregoing it will be seen that you have no engineering difficulties of moment to contend with west of the Indiana State line, and the construction of such a ditch as you contemplate is but a simple problem requiring no great engineering skill, except in careful leveling, that the excavation may be made to the proper grade, and when this is done the water will simply seek its level by running down hill.

I am indebted to Col. D. C. Houston, Corps of Engineers, United States Army, for most of the important calculations embraced in this report, he having kindly taken the notes with him to Washington during his recent trip to that city, and there made the calculations from the latest formulas in the office of the Chief of Engineers.

Respectfully submitted.

ENSIGN BENNETT,
Civil Engineer.

APPENDIX X.

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

GRADES AND CURVATURES UPON BRIDGES AND APPROACHES.

Upon the distribution of the report upon bridging the Mississippi River between Saint Paul, Minn., and Saint Louis, Mo., some disappointment was felt that it contained no tabulated statement of the grades used upon the bridges. As a matter of fact, all that could be ascertained about the grades on the bridges was given in the description of each bridge or on the drawings of them. The bridges, excepting those of the wagon-way at Saint Paul and the railway at Saint Louis, were draw-bridges and the grades were level, or nearly so; a table of these grades was of little value.

Such a table, however, has been prepared for the Mississippi River and sent herewith, giving curvature also; and as it is only in high bridges that grade is important, we have taken the table of grades, &c., on the Ohio River bridges from the report of the Board of Engineers, printed in the annual report of the Chief of Engineers for 1871, page 425.

These two tables cover a considerable range of examples. The highest railway grade given is on the bridge at Louisville, Ky., where it reaches 1.49 feet per 100 feet.

The grade on the Saint Louis Bridge is 1 foot in 100 feet, and this grade is also used at the Saint Charles Bridge across the Missouri River. These grades require either special engines or low rates of speed, and there is difficulty in holding the rail to the ties to prevent its *crawling* under the action of the driving wheels of the locomotive and the vibrations of the bridge.

The question of grades has little importance whenever a draw-bridge is allowable to accommodate navigation. But whenever the bridge is for a railroad system requiring constant service for hours at a time, or where the large amount of navigation would require the draws of a draw-bridge to remain open for continuous passage of vessels for many hours at a time, the accommodation of both means of transportation requires high bridges.

On high bridges where the railroad business is large and considerable speed of transit is required, the grade should be kept as low as possible with due regard to economy of construction. Where, in such cases, high grades are used, the strength, and rigidity must be increased with the grade, or special locomotives or stationary power should be employed. The advantages which this latter method presents will permit of much higher grades than can be allowed by traction engines.