Green Bay and Mississippi Canal Company in 1873. It is the intention to ultimately replace the brush and stone dams by more permanent structures.

The Upper Fox River for a great part of its course flows through a flat country, which is to a large extent overflowed in high-water.

To avoid flowage of lands as much as possible, the crests of the new dams have been placed low, only 2 feet above low-water. The additional depth required for navigation is secured by dredging, by which the bed of the stream is lowered. To still further reduce the amount of flowage it is considered advisable to make the dams movable, so that they can be taken out in whole or in part, thus lowering the level in the pool above. A dam of this character has been built near Eureka; it consists of a permanent weir 150 feet in length and a navigable pass 50 feet wide. Should it be found necessary there can be substituted for the permanent weir a movable dam. This dam will answer the purpose of regulating the water level, and at the same time it will admit the passage of boats at high-water without going through the lock.

The Board then considered the device of a movable dam invented by William B. Johns, of Georgetown, D. C. From the specifications presented by him, which accompany this report, the Board was of the opinion that the device was practicable for limited spans and small heights, but in the absence of detailed drawings and estimates, calculations of strains, &c., it was unable to decide definitely on the questions of practicability and cost. The Board therefore adjourned to await the completion of the necessary drawings and estimates. A preliminary report, dated November 14, 1878, was forwarded to the Chief of Engineers.

The Board reassembled at Baltimore, Md., at 10 a. m. on the 19th of February, 1879, in pursuance of the following order:

[SPECIAL ORDERS No. 13.]

HEADQUARTERS CORPS OF ENGINEERS,
Washington, D. C., February 8, 1879.

The Board of Engineer Officers, constituted by Special Orders No. 89, of August 9, 1878, from these headquarters, consisting of Maj. W. P. Craighill, Maj. D. C. Houston, Maj. W. E. Merrill, will assemble at Baltimore, Md., on the 19th of February, 1879, or as soon as practicable, for further consideration of the question of improvement of the Upper Fox River, Wis.

By command of Brigadier-General Humphreys.

GEORGE H. ELLIOT,
Major of Engineers.

Drawings, estimates, and calculations of the Johns dam, made by Wm. R. Hutton, civil engineer, were submitted to the Board. Wm. B. Johns was present and presented his views on the subject. The plans were prepared for a dam 200 feet long and 6 feet high. The Board arrived at the conclusion that the device of Wm. B. Johns, modified as shown on the detailed drawings, was practicable for the span and height above mentioned on the Upper Fox, *i. e.*, that it could be constructed and operated as claimed by the inventor.

In considering its application to the Upper Fox, the Board is of the opinion that it does not completely fill the requirements of a dam on that river, and that those requirements can be better and more economically met by other known methods. As before stated, it is not only desirable that a movable dam on this river should give a free passage to boats in certain stages of water, but that it should also admit of the maintenance of a fixed level in the pool above by removing portions of the dam. In the Johns dam this can only be done by partially withdrawing the entire dam, making an opening of the full depth of the dam and of a greater or less width according to the stage of water.

It is substantially an immense rolling gate, moving at right angles to the current. When partially withdrawn, the water would be forced through the narrow opening at the end of the dam with very great velocity, and with a certainty of causing dangerous scours and objectionable eddies. While this is a serious drawback, the vital objection to the Johns dam at this locality is the cost of operating it. The present dam can be operated by one man, generally the lock-tender, involving no additional cost. If we substitute for the permanent weir at the Eureka dam, a Poiree needle-dam, the upper ends of the needle being supported against a permanent bridge, all the requirements of a movable dam on the Upper Fox will be met at a minimum cost of construction and of operating. The device of William B. Johns contemplates the use of a movable dam without locks, or as a substitute for them. The instructions of the Board refer only to its application on the Upper Fox, where movable dams are needed in connection with the locks. The Board has not, therefore, considered its application to streams where there are no locks.

While the Board does not recommend the trial or adoption of this device on the Upper Fox River, it is of the opinion that it might answer very well in other localities, and one of the members of the Board has suggested that its application might be advantageous at the head of the Falls of the Ohio, where it is understood that the officer in charge contemplates constructing a movable dam.

Detailed drawings of the Johns dam, with modifications prepared by William R. Hutton, civil engineer, with report by him, are submitted herewith.

The Board adjourned at 3 p. m. on the 20th of February, 1879.

Respectfully submitted.

WM. P. CRAIGHILL,
Major of Engineers.
D. C. HOUSTON,
Major of Engineers.
WM. E. MERRILL,
Major of Engineers.

AA 5.

EXAMINATION OF WOLF RIVER, WISCONSIN.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., November 30, 1878.

GENERAL: I have the honor to transmit herewith a report of an examination of Wolf River, Wisconsin, made during the past season by Mr. John Pierpont, assistant engineer, with a map of the river compiled from county maps. This examination was called for by the river and harbor act passed at the last session of Congress. The radical improvement of this river, which is exceedingly tortuous (even more so than the map shows), would involve an extensive system of cut-offs and the construction of locks and dams to keep up the water-level.

The business (present and prospective) on the river does not warrant such an expenditure as is necessary for this purpose.

Existing navigation would, however, be greatly benefited by removing

the snags which have accumulated, cutting off the leaning trees, and deepening the water on the bars by means of wing-dams and dikes.

The estimate for such work, so as to obtain 4½ feet at low-water up to Shiocton, and 3½ feet up to Simple's Bridge, is $35,000.

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

D. C. HOUSTON,
Major of Engineers.

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

REPORT OF MR. JOHN PIERPONT, ASSISTANT ENGINEER.

MILWAUKEE, WIS., *November* 26, 1878.

SIR: In accordance with instructions dated Milwaukee, Wis., July 27, 1878, directing me to make an examination of the Wolf River, Wisconsin, from lake Poygan to the mouth of the Red River, I started from Lake Poygan with the United States steamscow Dekorra and party of five men, on the 9th of August, and made a rapid reconnaissance of the river, reaching the Red River on the 15th. The results of the examination are embodied in the following report, which I have the honor to submit:

The Wolf River rises in the northern part of Oconto County, and runs in a southerly direction, a distance of 112 miles in a straight line, when it joins the Fox River, and under the latter name, although the Wolf is the larger stream, as will be seen by their relative discharge, passes through Lake Winnebago and empties into Green Bay.

The river drains an area of about 4,300 square miles. From Lake Poygan to Shawano Rocky, about 10 miles below Red River, the Wolf River runs at low-water with a current varying from .5 to 1.1 mile per hour. The country is flat and low, with a sandy soil that opposes little resistance to the action of even this sluggish current, so that the course of the river is exceedingly tortuous. The distances from point to point along the river, as given me by lumbermen and others, were generally about three times as great as line distances would be. Upon three consecutive days, descending the river, and, of course, going in a southerly direction, when the boat was tied up for the night, I noticed that it was headed nearly due north.

About 4 miles below Howe's Landing the river runs in a straight line for nearly a mile, and the feature is considered so remarkable that the locality is generally known as "The Straights."

Above Shawano Rocky the country becomes more and more rolling, until near the headwaters it is almost mountainous. The river runs through this hilly region without the sharp and numerous bends that occur below, but the bed abounds with slight falls and rocky rapids.

The banks of the river, below the mouth of Red River, vary in height from 4 to 10 feet above the low-water surface, and as the river in flood rises from 6 to 12 feet above the summer stage, the banks are generally overflowed during freshets. The river-banks are almost invariably covered with a close growth of oak, maple, poplar, and other woods, while the country back from the river is, or has been, covered with pine of an excellent quality. The drain upon the pine has been so exhaustive that nearly all that remains is up near the headwaters and can last but a few years longer. The land that has been cleared is said to be good for agricultural purposes, and is being occupied by settlers upon the lines of the railroads. The annual capacity of the mills fed by Wolf River logs is 260,000,000 feet, and this has represented nearly the amount manufactured for a number of years up to 1876, when the production was only 140,000,000. The work of depletion has been going on since 1835, when the first sawlogs were floated to the government mills at Neenah. At first the mills were built at points on the river and the manufactured lumber rafted to market, but it was found more economical and better for the lumber to float the logs to Oshkosh and Fond du Lac to be sawed. The Wolf River Boom Company was formed, a cut-off made from the river to Boom Bay (a part of Lake Poygan), and all logs coming down the river are received here, sorted according to the owner's marks, made into rafts, and towed to the mills. The managers of the boom company promised to furnish me with statistics of the amount of hard and soft lumber, cut and uncut, upon the main river and its tributaries, but up to this date I have not received the information. From my own observation, however, I can say that, though the pine is nearly gone, there is an immense quantity of hard-wood timber standing along the river and its branches, which is destined, at no distant day, to be of great value.

Navigation upon the river has been quite extensive, nearly all the lumbermen's supplies having been carried up at times of high-water, and even now a daily line of steamboats between Oshkosh and New London is said to pay well though running in opposition to the railroads. The amount of business done by the line I have been unable to ascertain. Several other boats ply upon the river, bringing down railroad ties, hemlock bark, cord wood, poplar bolts for paper pulp, and other products that cannot be rafted. At times of high-water the navigation is easy up to Shawano Rocky, which is the head of navigation, as at this point the rock bottom and rapids commence. This is about 10 miles below the mouth of the Red River, and about 4 miles above Simple's Bridge, which is itself, however, the real head of navigation, as the bridge has no draw, and the examination from here to the mouth of Red River was made in a skiff. The difference in the navigation at different seasons is shown by the fact that last spring a tug and two barges reached Simple's Bridge without trouble, though drawing 4½ feet, while in August the Dekorra, drawing 2 feet, went up to the bridge with difficulty.

The first town of any size reached in ascending the river is Fremont, which has a population of about 450. A wagon-bridge, the first bridge on the river, crosses at this point. Gill's Landing, where the Wisconsin Central crosses the river, is merely a hamlet, as are Stanley's Landing and Mukwa. Northport, the next town, has from 450 to 500 inhabitants, a wagon-bridge crossing the river, and two saw-mills. Besides being on the river, it is a station on the Green Bay and Minnesota Railroad. New London, the next town, is at the mouth of the Embarrass River, and is the most important, having a population of about 3,000. It is also a station on the Green Bay and Minnesota Railroad, and until recently has been the terminus of the Milwaukee, Lake Shore and Western Railroad, but the road has been extended during the present year in a northerly direction to Clintonville. Shiocton, at the crossing of the Green Bay and Minnesota Railroad, is a small village of about 200 inhabitants, passing which there are only small hamlets or isolated houses, until Shawano, a town of about 1,000 inhabitants, is reached. Shawano is about 2½ miles above the head of natural navigation (Shawano Rocky), and lies on the Shawano River about ½ mile from the Wolf River. It is quite a business point, being a distributing center for lumbermen's supplies, which are brought to Shawano by wagon from the nearest railroad station.

The map accompanying this report shows the whole of the Wolf River and the area drained by it, on a scale of ½ inch to the mile. It has been compiled from county maps, but is not accurate, as the river is much more crooked than shown. There is also on the map a profile along the channel line made from soundings taken during the reconnaissance. The water line represents the low-water surface as nearly as I could judge from the information given me by lumbermen and residents on the bank. The lower part of the river was about 1½ feet above its usual low-water stage, owing to the high stage existing in Lake Poygan and Winneconne, but above this influence at Shiocton, all coincided in the opinion that the water was dead low. The slope of the surface was not determined, I measured from the water surface to the track grades of each of the three railroads that cross the river, hoping to obtain the track elevations above Lake Michigan and thus the approximate slope, but the elevations given by the railroad companies were too conflicting and uncertain to be of value.

Cross-sections of the river were made at intervals, and are shown in detail on the map, their location on the river being also shown. The first was made a short distance above Fremont, where the river was all in one channel, and a straight base-line of 425 feet was obtained. The river was carefully gauged at this point with submerged floats, passing over the entire section of 425 feet. All other cross-sections were obtained from a single line of soundings taken at intervals of 5 feet across the river, and the velocity obtained by noting the time required for a surface-float to pass over a distance of 20 feet.

The following table gives the discharges of the river as computed from these observations, the mean velocity being taken at 85 per cent. of that at the surface.

Table of discharges, Wolf River, Wisconsin.

Number.	Date.	Location of cross-section.	Area, square feet.	Mean volume, feet per second.	Discharge, cubic feet per second.
1	Aug. 9	Above Fremont	2,010.4	0.8	1,608.32
2	Aug. 9	Mukwa	1,480	0.91	1,346.8
3	Aug. 10	New London	850	1.4	1,150
4	Aug. 11	Below mouth of Stephensville Creek	658.8	0.773	509.25
5	Aug. 12	Above mouth of Shioc River	454.4	1.13	513.47
6	Aug. 13	Stinson post-office	456.25	1.41	642.96
7	Aug. 13	South line Shawano County	474	1.2	568.8
8	Aug. 14	Howe's Landing	527.5	1.7	896.75
9	Aug. 14	Simple's Bridge	476	1.7	809.2
10	Aug. 15	Town-line Bridge	402	1.3	522.6
11	Aug. 15	Above mouth of Red River	242	1.78	430.76
12	Aug. 15	Red River, above its mouth	98	1.06	103.88

The sudden increase in the discharge between Nos. 7 and 8 was made by a rise in the river on the night of August 13, caused by opening a dam on the headwaters to let down a drive of logs.

Discharge of the Fox River, at Eureka Dam, on the 9th of August, was as follows

Head of water above crest of dam	21 inches.
Length of crest	150 feet.

Neville's formula:

(1) Discharge in cubic feet per minute $=7.72\ l\ \sqrt{h^3}$ becomes, by taking the coefficient at .563 (determined by Mr. Frances' experiments at Lowell, Neville on Hydraulics, page 121) and the discharge in cubic feet per second.

(2) Discharge in cubic feet per second, $\frac{4.34 \times 150 \times 21\ \sqrt{21}}{60} = 1{,}043.5$.

On the same day (August 9) the Wolf River discharged 1,608.32 cubic feet per second, showing that it is $1\frac{1}{2}$ times larger than the Fox.

The Wolf River presents four classes of obstructions to navigation: 1st, bends; 2d, bars; 3d, leaning trees; 4th, snags.

As no benefit would be obtained by cutting off the bends and straightening the river without introducing a system of locks and dams to make slack-water, and as there seems to be no prospective business to warrant the large cost of such an improvement, the first class will not be considered.

The second class of obstructions, bars, are always of sand, and occur under two conditions: first, on reaches of the river that are comparatively wide and straight; and, second, invariably in the bends.

Mukwa and New London Bars, shown on the map which accompanies this report, are examples of the first, while the sketch of a double bend and the characteristic bars is an example of the second. Bars in the bends are obstructions only in connection with the leaning timber, as there is generally a good depth of water over the crests close to the concave side of the bends. But the current undermines the bank on the concave side, causing the trees to fall into the river and become snags, or to lean over the deep water, so that, were the river banks cleared of all the timber that is liable to be undermined in the future, the bars under consideration would need no further improvement.

Bars that are found in wide portions of the river it would be necessary to remove, either by dredging or by the current. These, such as Mukwa, New London, and Conley's Rips, are permanent bars, and if removed by dredging would probably form again in the same places, especially the two first mentioned, as from their location just below the mouths of the Little Wolf and the Embarrass, two of the largest affluents of the Wolf, it would seem as though they were made in great part of the sand brought down these streams. Moreover, the water surface would be lowered if the bar were dredged out, and reaches of the river above the bars where a good depth of water now obtains would be deteriorated. Wherever the river is from 90 to 125 feet wide there is always deep water, whether the river is straight or not, so the best plan is obviously to reduce the width wherever necessary by jetties and wing-dams, built of brush and snags, the new width to be so adjusted that the surface slope will not be materially altered, and the regimen of the river remain unchanged.

From Lake Poygan up to Shiocton, a distance of 78 miles by the river, there is now a low-water channel of $4\frac{1}{2}$ feet, except nine short bars up to Mukwa, aggregating 3.500 feet in length (from $4\frac{1}{2}$ feet in depth below each bar to $4\frac{1}{2}$ feet in depth above): Mukwa bar, 1,100 feet long; Little Wolf, 1,750 feet; Northport, 200 feet; New London, 4,950; three bars between the mouth of Stephensville Creek and Conley's Rips, 5,200 feet; and one just below Shiocton; 500—making a total length of 17,100 feet of the river that will need improving.

From Shiocton up to Simple's Bridge, a distance of about 50 miles, there is less than $4\frac{1}{2}$ feet of water for nearly half the distance, less than $3\frac{1}{2}$ feet for about 8 miles, and less than $2\frac{1}{2}$ feet for about 1 mile; while the shoalest water found, 2 feet, except one spot of 20 inches, extends only a few hundred feet.

Considering the vast amount of material that must be removed by the current if an attempt is made to carry $4\frac{1}{2}$ feet to Simple's Bridge, and the possibly impracticable task of making such a radical change in the river by jetties, I think it would be better to carry $4\frac{1}{2}$ feet to Shiocton, and $3\frac{1}{2}$ feet from there to Simple's Bridge. Upon this basis there will be $11\frac{1}{4}$ miles of the river to be improved. The bars under consideration occur as stated, in the wide portions of the river, but this width is generally from 200 to 250 feet—in no case more than 300; so the jetties would be very short, and being on the bars themselves would be built in shoal water. One entire bar, about 500 feet long, just below the head of the "Big Cut-off," could probably be improved by a small dam closing up the cut-off and throwing all the water over it. The influence of a jetty can be considered as extending up and down the river a distance of about 5 times its length, so that it will require $2\frac{1}{4}$ miles of jetties to improve the $11\frac{1}{4}$ miles of river. The estimated cost of these, built of brush, timber, and snags, will be $1.50 per foot, giving a total cost of the $2\frac{1}{4}$ miles of $17,280.

Leaning trees, the third class of obstructions, extend on one bank, and sometimes on both, nearly the whole length of the river, from the head of the "Big Cut-off" to Simple's Bridge, a distance of 97 miles. Many of the leaning trees have been cut off by boatmen and raftsmen, but the work has been done only as a temporary relief in each case, and in many places the stumps have been left projecting from 5 to 10 feet over the bank. As these are generally on the concave side of the bends, a boat descending is extremely liable to be carried into them broadside by the current.

The work of clearing the banks could best be done in winter when the trees can be felled on the ice and dragged off to the bank by ox-teams. Several practical lumbermen with whom I talked thought the work could be done for $12 per mile of river, which would make the cost $1,164 for the length of the river on which the work is required.

Snags, the fourth class of obstructions, abound in greater or less numbers from the head of the Wolf River Boom Company's cut-off to Simple's Bridge, and are the most serious impediments to navigation, because the most dangerous.

I took pains during the trip down the river to count all the snags, and as the water was low and clear only those in the deepest places where they form no obstruction to navigation could have been missed. Between Simple's Bridge and Shiocton, 50 miles, there were 4,532 snags, about 90 to each mile; between Shiocton and New London, 30 miles, there were 2,200, about 70 to the mile, and from New London to Boom Company's Cut-off, 43 miles, there were 2,067, about 50 to the mile. Many of the snags are small, and nearly all could be raised by a boat with a steam-derrick on the bow by which the snags could be swung on to the bank or on scows alongside to be deposited in the works for the contraction of the river. Others are really sunken logs, principally oak, of considerable value and well worth the cost of raising them. I think that, taking the snags as they run, $1.25 each would cover the cost of removing them, for while it would cost more to take out the large ones, there are very many small ones that would cost much less. This gives for the cost of removing 8,799 snags, at $1.25 each, $10,998.75; about $90 per mile for the 123 miles obstructed by snags.

The cost of improving the Wolf River from Lake Poygan to Simple's Bridge to obtain $4\frac{1}{2}$ feet of water at low-water to Shiocton, and $3\frac{1}{2}$ feet for the remainder of the distance, would be as follows:

Removing bars by jetties	$17,820 00
Removing leaning trees	1,164 00
Removing snags	10,998 75
	29,982 75
Engineering and contingencies, about 17 per cent	5,017 25
Total cost	35,000 00

Very respectfully, your obedient servant,

JOHN PIERPONT,
Assistant Engineer.

Maj. D. C. HOUSTON,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., December 24, 1878.

GENERAL: I have the honor to report the following statistics in reference to the business on the Wolf River, Wisconsin, supplementary to my report on the examination of that river, dated November 30, 1878. The information has been furnished by Mr. Thomas Wall, of Oshkosh, Wis., superintendent of the Wolf River Transportation Company, and his brother, Mr. William Wall.

The number of boats running on Wolf River during the season of 1878 was 7; total tonnage, 690. "Three thousand tons of merchandise, carried as follows: 40,000 bushels wheat; 2,600 barrels flour; 2,100 barrels salt; 100 tons coal; 7,000 cords wood; 2,000 cords hemlock bark; 2,400 cords stave-bolts; 100,000 hoop-poles; 100,000 cedar posts; 35,000 oak railroad-ties; 1,000 tons staves and headings; 3,000,000 feet manufactured lumber."

Estimated quantity of standing timber on the Wolf River and its tributaries:

	Feet, b. m.
Pine	2,200,000,000
Hemlock	1,400,000,000
Oak, ash, elm, &c	1,150,000,000

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

D. C. HOUSTON,
Major of Engineers.

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