1885

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE MOUTHS OF THE ILLINOIS AND OHIO RIVERS—IMPROVING HARBOR AND MISSISSIPPI RIVER AT ALTON—MISSISSIPPI RIVER OPPOSITE THE CITY OF SAINT LOUIS, AND AT OR NEAR CAPE GIRARDEAU AND MINTON POINT.

Officer in charge, Maj. O. H. Ernst, Corps of Engineers, having under his immediate orders, until August 5, 1884, First Lieut. F. V. Abbot, Corps of Engineers.

1. *Mississippi River between the Illinois and Ohio Rivers.*—No work in the field was done during the year under the direction of the Chief of Engineers. A portion of the small balance, $5,354.51, available at the beginning of the year was employed in caring for the public property until the works were transferred to the Mississippi River Commission in accordance with a provision of the act of July 5, 1884. The remainder of this balance was used in continuing the works under their direction. The action of the works previously constructed by the Engineer Department continued to be favorable.

July 1, 1884, amount available	$5,354 51
July 1, 1885, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1884	5,354 51

(See Appendix X 1.)

2. *Harbor and Mississippi River at Alton.*—By a provision in the act of July 5, 1884, the supervision of this work was transferred to the Mississippi River Commission. Nothing was done during the year under the direction of the Chief of Engineers.

(See Appendix X 2.)

3. *Mississippi River opposite the city of Saint Louis, Missouri.*—By a provision in the act of July 5, 1884, the supervision of this work was transferred to the Mississippi River Commission. Nothing was done during the year under the direction of the Chief of Engineers.

(See Appendix X 3.)

4. *Mississippi River at or near Cape Girardeau, Missouri, and Minton Point, Illinois.*—By a provision in the act of July 5, 1884, the supervision of this work was transferred to the Mississippi River Commission. Nothing was done during the year under the direction of the Chief of Engineers.

(See Appendix X 4.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF JULY 5, 1884.

The following was examined by the local engineer in charge, Maj. O. H. Ernst, and not recommended for improvement:

1. *Osage River, from mouth to Linn Creek, with a view to movable locks and dams.*—The report was transmitted to Congress and printed in House Ex. Doc. No. 71, Forty-eighth Congress, second session.

(See also Appendix X 5.)

IMPROVEMENT OF THE YELLOWSTONE RIVER, DAKOTA AND MONTANA—IMPROVEMENT OF THE MISSOURI RIVER FROM SIOUX CITY, IOWA, TO FORT BENTON, MONTANA.

Officer in charge, Capt. James B. Quinn, Corps of Engineers.

1. *Yellowstone River in Montana and Dakota.*—During the year the work of improving the navigable channel by brush-dam constructions

APPENDIX X

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN THE MOUTHS OF THE ILLINOIS AND OHIO RIVERS—IMPROVING HARBOR AND MISSISSIPPI RIVER AT ALTON, MISSISSIPPI RIVER OPPOSITE THE CITY OF SAINT LOUIS, AND AT OR NEAR CAPE GIRARDEAU AND MINTON POINT.

REPORT OF MAJOR O. H. ERNST, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1885.

IMPROVEMENTS.

1. Mississippi River between the Illinois and Ohio rivers.
2. Harbor and Mississippi River at Alton.
3. Mississippi River opposite the city of Saint Louis, Mo.
4. Mississippi River at or near Cape Girardeau, Mo., and Minton Point, Ill.

EXAMINATION.

5. Osage River, Missouri, from mouth to Linn Creek, with a view to movable locks and dams.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., July 8, 1885.

GENERAL: I have the honor to transmit herewith the annual reports for the last fiscal year upon the works under my charge.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

X 1.

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE ILLINOIS AND OHIO RIVERS.

At the date of my last annual report the works were suspended, the appropriation being very nearly exhausted. The river and harbor act of July 5, 1884, provided that the sums therein "appropriated for the Mississippi River, from the Des Moines Rapids to the mouth of the Ohio, shall be expended under the direction of the Secretary of War, in accordance with the plans, specifications, estimates, and recommendations of the Mississippi River Commission," and under date of July 21, 1884, I

was ordered to report to the Commission. A portion of the small balance remaining available at the beginning of the fiscal year had been used in office expenses and in caring for the public property. The remainder was expended under the direction of the Commission. Accordingly no work of construction has been done under the immediate direction of the Chief of Engineers during the year.

The hurdles previously constructed continued to act favorably during the year, causing heavy additional deposits. The progress made in building up the new banks is shown upon Plates I, II, and III, herewith transmitted, the works constructed during the present year, of course, contributing to these results. Plates IV and V show the forms of construction for hurdles and bank protection, respectively, as they were finally perfected, when the works left the hands of the Engineer Department.

Money statement.

July 1, 1884, amount available	$5,354 51
July 1, 1885, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1884	5,354 51

X 2.

IMPROVEMENT OF THE HARBOR AND MISSISSIPPI RIVER AT ALTON, ILLINOIS.

Nothing was done here during the year under the direction of the Chief of Engineers. By a provision in the act of July 5, 1884, the supervision of the work devolved upon the Mississippi River Commission.

X 3.

IMPROVEMENT OF MISSISSIPPI RIVER OPPOSITE THE CITY OF SAINT LOUIS, MISSOURI.

Nothing was done here during the year under the direction of the Chief of Engineers. By a provision in the act of July 5, 1884, the supervision of the work devolved upon the Mississippi River Commission.

X 4.

IMPROVEMENT OF THE MISSISSIPPI RIVER AT OR NEAR CAPE GIRARDEAU, MISSOURI, AND MINTON POINT, ILLINOIS.

Nothing was done here during the year under the direction of the Chief of Engineers. By a provision in the act of July 5, 1884, the supervision of the work devolved upon the Mississippi River Commission.

1886

IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND DAKOTA.

Officer in charge, Capt. James B. Quinn, Corps of Engineers.

During the past season the work has progressed in accordance with present project and has consisted in the construction of brush-dams, for the closing of chutes and cut-offs in the portion of the river below Glendive. These dams aggregate a total of 1,282 linear feet and were built at an average cost of $5.79 + per linear foot, the lowest average rate as yet reached in the construction of such works on the Yellowstone River.

ESTIMATES.

For necessary plant to continue operations	$14,000
For expenses of working parties for one season's operations	25,700
For repairs to dams	5,000
For new barges and dredge-boat	30,000
Total that may be profitably expended during the next year	74,700

Exclusive of repairs to dams the cost of the improvement of the river from Glendive to the mouth will not probably exceed $106,000.

July 1, 1885, amount available		$10,112 32
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$8,402 56	
July 1, 1886, outstanding liabilities	1,016 25	
		9,418 81
July 1, 1886, amount available		693 51
Amount appropriated by act approved August 5, 1886		18,750 00
Amount available for fiscal year ending June 30, 1887		19,443 51
Amount (estimated) required for completion of existing project		106,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

(See Appendix W.)

IMPROVEMENT OF THE MISSISSIPPI RIVER FROM THE MOUTH OF THE ILLINOIS TO THE MOUTH OF THE OHIO.

Officer in charge, Maj. O. H. Ernst, Corps of Engineers.

The supervision of the work in progress on this portion of the river having passed to the Mississippi River Commission, by provisions of the river and harbor act of July 5, 1884, report of operations here during the fiscal year ending June 30, 1886, is made by that Commission.

The river and harbor act of August 5, 1886, in making appropriation for continuing this improvement, returns its supervision to the Chief of Engineers as heretofore.

Amount appropriated by act approved August 5, 1886	$375,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	600,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

IMPROVEMENT OF THE MISSISSIPPI RIVER FROM DES MOINES RAPIDS TO THE MOUTH OF ILLINOIS RIVER.

Officer in charge, Capt. E. H. Ruffner, Corps of Engineers.

The supervision of the work in progress on this portion of the river having passed to the Mississippi River Commission by provisions of the

1887

With the appropriation asked for the fiscal year ending June 30, 1889, it is proposed to continue the snagging operations and rebuild one of the wooden snag-boats for wrecking purposes.

No definite amount can be stated as required to complete this project. During every high-water season new snags and other obstructions are brought down and lodged in the channel; the banks are also continually caving in the river, and it is necessary to cut the timber where this is threatened to prevent the trees being caved into the river and forming new obstructions. For this reason an annual appropriation is required to properly carry on these operations.

July 1, 1886, amount available	$8,407.88
Amount appropriated by act approved August 5, 1886	56,250.00
	64,657.88
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	43,583.12
July 1, 1887, amount available	21,074.76
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	129,000.00

(See Appendix W 1.)

Missouri River.—The necessity for the improvement of this stream was first recognized in 1832. The plan adopted was the removal of these obstructions by snag-boats, and they have been used to great advantage.

The first appropriations being made so as to cover the needs of several streams, the total amount expended on this river for the removal of obstructions cannot be given. Since June 18, 1878, however, when the first specific appropriation was made, up to June 30, 1886, $396,876.11 was expended in that manner, greatly improving navigation during the low-water season.

During the fiscal year ending June 30, 1887, $59,430.35 was expended in removing obstructions and in building a new snag-boat for this river, which is nearly completed. One snag-boat only was employed in removing obstructions.

With the appropriation asked for fiscal year ending June 30, 1889, it is proposed to complete the outfit of new boat and continue the snagging operations, and it is expected that the worst obstructions can be removed, and navigation rendered comparatively safe.

As new obstructions are continually brought down the river, work is required every year, so that an annual appropriation is necessary.

July 1, 1886, amount available	$43,123.89
Amount appropriated by act approved August 5, 1886	22,500.00
	65,623.89
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	59,430.35
July 1, 1887, amount available	6,193.54
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	44,000.00

(See Appendix W 1.)

2. ***Mississippi River, between the Ohio and Illinois rivers.***—Work was carried on at Piasa Island, Horsetail, Twin Hollows, Chesley Island, Jim

Smith's, and Sulphur Springs. These works, except the work at Piasa Island, form parts of one connected whole, carried on under a general scheme of making the improvement of the river continuous, beginning at Saint Louis and working down-stream, reducing the river to an approximately uniform width of about 2,500 feet, and protecting the banks from erosion. The work between the Illinois River and Saint Louis consists in the maintenance of a channel of 6 feet in depth.

Piasa Island.—The work at this point consisted in the removal of a sand-bar, which had formed below the opening made in the dike, to afford a low-water channel. The work was accomplished at a small expense. Amount expended during fiscal year, $366.75. There is not at this time any definite project for the improvement of this locality.

Horsetail, Carroll Island.—The work at this point, which is at the foot of the Horsetail Reach, consisted in the repair of the hurdle intended to close the chute to the east of Carroll's Island. A break of 1,000 feet was made in this hurdle by the ice in February, 1886. The amount expended during the fiscal year ending June 30, 1887, was $9,877.66. The total amount expended to June 30, 1887, on the Horsetail improvement has been $896,147.22; of this amount $225,066.31 was expended before the adoption, in 1879, of the present project. It has resulted in securing a direct navigable channel with a depth of 8 feet. Further work may be required to preserve this result.

Twin Hollows, west bank.—The present project for the improvement of this locality was adopted in 1881, the object being to afford a channel of not less than 8 feet; the natural channel was often not more than 4 feet deep in the shoalest parts. The work consisted of a bank revetment 2,633 feet in length. The amount expended during the fiscal year was $19,161.31. The total amount expended to June 30, 1887, was $248,837.82, and has resulted in securing a navigable channel of not less than 8½ feet. It is proposed during the coming year to continue the protection as needed.

Twin Hollows, east bank.—The present project for the improvement of this locality was adopted in 1881, the object being to stop the caving, which extended over a length of 8,400 feet of bank, and the consequent deterioration of the channel. Before the work was begun the caving was progressing at the rate of several feet per day.

The work done here for the fiscal year consisted in the repair of the revetment. The amount expended during the year was $3,460.73. The total amount expended to June 30, 1887, was $128,920.30, and has resulted in the protection of 11,400 feet of bank. Of this about 2,809 feet still requires additional protection to high-water mark. During the coming year it is proposed to complete this protection.

Pulltight.—The present project for the improvement of this locality was adopted in 1881, the object being to afford a channel not less than 8 feet in depth. The natural channel was often not more than 4 feet deep in the shoalest parts. No work was done during the year at this locality, as it is probable the river is not in a stable condition, and it was thought best to defer work until the channel should become more direct. The least depth in the channel at this place and at Twin Hollows was 8½ feet during the season. The total amount expended to June 30, 1887, was $123,600.40. It is proposed during the coming year to resume work at this place, if found expedient.

Chesley Island.—The present project for the improvement of this locality was adopted in 1881, the object being to stop the erosion of the east side of the island, and the consequent deterioration of the navigation, and also to close the chute west of the island, in order to afford, in con-

nection with the works at Jim Smith's, a channel not less than 8 feet deep. The bank was caving at the rate of several feet per day, and the natural channel was often not more than 4 feet deep in the shoalest parts. The ice during the winter had broken a gap in the hurdle designed to close the chute to the west of the island. This gap has been closed, and the revetment of the east side of the island is in good condition. The amount expended during the year was $9,117.55. The total amount expended to June 30, 1887, was $91,224.65, and has resulted in the protection of the east side of the island for a distance of 4,305 feet, and in closing partially the chute, affording, in connection with the improvement at Jim Smith's, a navigable channel of not less than 8 feet. It is not proposed to do any work here during the coming year unless repairs may be again required.

Jim Smith's.—The present project for the improvement of this locality was adopted in 1881, the object being to afford a channel not less than 8 feet in depth. The natural channel was often not more than 4 feet in its shoalest parts. The amount expended during the year was $2,590.63, and the work consisted in the raising of the wattling to 16 feet above low water. The total amount expended to June 30, 1887, was $309,114.46, and has resulted in obtaining a navigable channel in which the depth during the year was not less than 8 feet. During the coming year the work proposed will be necessary repairs.

Sulphur Springs.—The present project for the improvement of this locality was adopted in 1881, the object being to afford a channel not less than 8 feet in depth; it is in fact a continuation of the work at Jim Smith's. Work was begun in the fall of 1886, and continued during the spring of 1887. The amount expended during the fiscal year was $152,717.26. The total amount expended to June 30, 1887, was $152,717.26. The works are of too recent date to state that they have yet produced any effect, but will require another season to develop a decided benefit. The work for the coming year will consist in the continuation of this work down-stream.

Bank protection at Cairo.—The work at this point consisted in the repair of the riprapping and the sinking of a mattress 544 feet in length. About 3,500 square feet of riprapping was repaired. The object of this work was the prevention of a threatened cut off into the Ohio River, which would have separated Cairo from the mainland. The work has succeeded in holding this point and the river has changed its course, so that there is no longer any danger, a large fill having been made along the threatened bank.

The amount expended during the fiscal year was $8,045.51, and the total amount expended to June 30, 1887, was $160,439.32. During the coming season no work is proposed, unless some unexpected emergency should call for it.

With the appropriation asked for fiscal year ending June 30, 1889, it is proposed to carry out the projects heretofore adopted, that is, to make the improvement continuous, beginning at Saint Louis and working down-stream. The changeable character of the river renders it impracticable to give in advance the exact localities where work will be required.

The original estimated cost of the work, as revised in 1883, was	$16,997,100.00
The aggregate amount appropriated to June 30, 1887, is	3,739,600.00
The amount expended to June 30, 1886, is	3,328,431.87
The amount expended during fiscal year ending June 30, 1887, exclusive of outstanding liabilities, is	193,076.63

July 1, 1886, amount available		$41,309.65
Miscellaneous receipts		1.88
Amount appropriated by act approved August 5, 1886		375,000.00
		416,311.53
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$193,076.63	
July 1, 1887, outstanding liabilities	7,061.88	
		200,138.51
July 1, 1887, amount available		216,173.02
Amount (estimated) required for completion of existing project		13,257,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		600,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix W 2.)

3. *Gasconade River, Missouri.*—This river was greatly obstructed by snags, logs, and leaning timber, which materially interfered with navigation. Work was commenced on this stream in 1880, and the project adopted for its improvement consisted in the removal of the snags and logs, and the cutting of the leaning timber.

The amount expended to June 30, 1886, was $29,070.95, and at that time the navigation was much improved. During the fiscal year ending June 30, 1887, $5,353.44 was expended in continuing the removal of obstructions from the stream.

During the coming season these operations will be continued as long as the funds available will permit.

With the amount asked for fiscal year ending June 30, 1889, it is proposed to continue the removal of obstructions and to close some of the side chutes, in order to concentrate the water in the main channel of the river.

The original estimate for the improvement of this stream was $50,000, of which $37,500 has already been appropriated, leaving an estimated amount of $12,500 to complete the project. This amount will probably be exceeded, however, as new obstructions are continually forming, and it will require a small amount each year to keep the channel open after the principal work has been done.

July 1, 1886, amount available		$929.05
Amount appropriated by act approved August 5, 1886		7,500.00
		8,429.05
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886		5,353.44
July 1, 1887, amount available		3,075.61
Amount that can be profitably expended in fiscal year ending June 30, 1889		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix W 3.)

4. *Osage River, Missouri and Kansas.*—The navigation of this stream was greatly interfered with by obstructions in the channel and shoal crossings. The original project, adopted in 1871, was to obtain a low-water navigation of 2 feet by means of dams and training-walls, but this was abandoned and no other definite project was adopted. The improvements have consisted in the removal of overhanging trees from the banks, and of snags from the bed of the stream, and the construction of wing-dams and training-walls. The amount expended to June 30, 1886,

Engines (compound oscillating and condensing): High-pressure cylinder, 20½-inch diameter; low-pressure cylinder, 32-inch diameter; stroke, 4 feet; cut-off, $\frac{7}{12}$ stroke.
Boilers (3): 42 inches diameter, 26 feet long, with 4 flues 9½ inches diameter.
Water-wheels: Diameter, 16 feet; length of buckets, 11 feet.

The benefit of the snag-boat service to the Missouri River is obvious; the necessity for the work has been set forth in the remarks on the Mississippi River. This stream is peculiarly liable to snags, as it has a constant tendency to change, and attacks its caving banks with great violence.

With the appropriation recommended for the fiscal year ending June 30, 1889, it is proposed to outfit the new snagboat and work her in the river as long as the season and funds will permit.

ESTIMATES.

For outfitting and completing snagboat	$10,000
For operating boat six months, at $4,000 per month	24,000
For repairs, incidental expenses, etc	10,000
Total	44,000

Money statement.

July 1, 1886, amount available	$43,123.89
Amount appropriated by act approved August 5, 1886	22,500.00
	65,623.89
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	59,430.35
July 1, 1887, amount available	6,193.54
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	44,000.00

W 2.

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE OHIO AND ILLINOIS RIVERS.

I assumed charge of these works, relieving Maj. O. H. Ernst, Corps of Engineers, on November 13, 1886, by virtue of Special Orders No. 243, Adjutant-General's Office, Washington, October 19, 1886.

This report includes the operations for the entire fiscal year.

PROJECT.

The object of the improvement is to obtain a minimum depth at low water of 6 feet from the Illinois River to Saint Louis, a distance of 41 miles, and 8 feet from Saint Louis to the Ohio River, a distance of 191 miles, the natural depth being in many cases from 3½ to 4 feet. The initial point of the work, for the lower portion, is Saint Louis, the program being to make the work continuous, working down-stream from that city. Work at detached points has also been carried on under allotments specially made by law for the improvement of landings and the protection of local interests.

The plan for the general improvement contemplates a reduction of the river to an approximate width of 2,500 feet below Saint Louis, the

natural width being in many cases from 1 to 1½ miles, and to protect the alluvial banks from erosion. The methods employed are to build up new banks with the solid matter caught from the river itself by means of hurdles and revetment of the banks both new and old.

ORGANIZATION.

The organization of the engineering staff during the season was as follows:

A supervising engineer was assigned to the general supervision of all the works and of the supply depot; his office was in Saint Louis, and his duties were to advise and direct the resident engineers, and to have special charge of the supply of brush and stone and of the towboat and barges engaged in that work.

The resident engineer was provided with quarters and an office at the work. His duties were to have immediate direction of the work of construction, to make such surveys and observations as might be required to keep the progress map, upon which all work was to be located as fast as constructed, to keep the journal and other records of the work, to prepare pay-rolls, to render quarterly property returns, to supervise the kitchen, mess rooms, and quarters, and to render weekly, monthly, semi-annual, and annual reports to the officer in charge, forwarding them through the superintending engineer. The superintending engineer was Mr. D. M. Currie. Resident engineers: At Horsetail (Carroll's Island), Mr. W. S. Mitchell; at Twin Hollows (east and west bank), Mr. W. S. Mitchell, assisted during the fall season by Mr. E. D. Libby; at Chesley Island, Mr. John O. Holman; at Jim Smith's and Sulphur Springs, Mr. John O. Holman, assisted by Mr. C. D. Lamb; in charge of procurement of brush, Mr. J. E. Savage.

WORK ACCOMPLISHED.

Owing to the small amount of funds available the work laid out for the year consisted only in the extension of the Jim Smith works downstream, the new work being designated as the Sulphur Springs work, the repair of damages caused by the ice, and the revetment of the banks (east and west) at Twin Hollows. Plate 1 is a general map of the river between the Saint Louis Bridge and Foster's Island, a distance of 27 miles, showing the location of these places.

HORSETAIL.

The work at this locality consisted in the repair of the Carroll's Island hurdle. The serious damage sustained by this hurdle from the breaking up of the ice in February, 1886, consisted of a break beginning 500 feet east of the angle in the hurdle and extending 1,000 feet to the sand-bar, and a number of separately displaced and broken braces, stringers, and piles. These last were mostly confined to the drift row.

In the main break no vestige of the hurdle remained except the mattress, which was found in place. The depth of water flowing through the break was about 10 feet, and the current very strong. The line was re-established without difficulty, with three rows of oak piles with braces and stringers, as in the ordinary type of hurdle, and in addition the hurdle was wattled to a 20-foot stage, beginning at the sand-bar and extending around the angle to Carroll's Island, a distance of 2,200 feet.

In the old portion of the hurdle the wattling had been placed as high as 12-foot stage, but was found very much broken and was repaired.

All of the displaced piles, braces, and stringers were reset, and all bolts in the old work were tightened or renewed where necessary.

Work was completed April 29, when the quarterboats and outfit were removed to Pulltight, Ill., where, after taking down and loading on a barge for removal all the portable buildings at that camp, the force of laborers was discharged.

The immediate effect of wattling the Carroll's Island hurdle was to shut off the large body of water flowing back of the island and to increase the draught of the water across the hurdle below the angle where the current still endeavors to pass across the head of the island. A slight surface cutting of the bar above the island resulted, but as the sand washed off seemed to be deposited in the passage east of the island, no serious damage was done.

The condition of the hurdles and bars above the Carroll's Island hurdle is substantially the same as that given in the last annual report, the only change observed being the loss of about 40 feet of piling at the outer end of secondary hurdle No. 32, and a general deterioration in the condition of the wattling in all the hurdles, due in great part to gradual decay.

The works at Horsetail have succeeded in obtaining the result required, that is, a channel depth of not less than 8 feet. The contraction of the channel to 2,500 feet is gradually taking place and will no doubt be accomplished in the near future.

This was formerly one of the worst places below Saint Louis, but now the boats navigating the river find no difficulties here.

Plate No. 2 shows the condition of the work on June 30, 1887.

TWIN HOLLOWS.

East bank.—The work here consisted in the repair of revetment.

No work had been done in this locality since the fall season of 1884, at which time the primary hurdle and secondary hurdles Nos. 1, 4, and 5 were repaired, and the works generally were in good condition.

After the high water had passed, an examination of the bank at this place showed that the stone-work in the revetment was broken and needed repairs for half a mile below a point about opposite to the Upper or North Twin Hollow on the west bank, and, in addition, that the two large circular caves which were in this section of the bank, and which had previously been revetted, had been seriously enlarged, and the riprapping in them almost entirely destroyed through the slipping of the bank.

In the repairs the stone was removed wherever necessary and after grading the bank it was replaced, and if insufficient to thoroughly revet the spot, it was supplemented with new stone.

The outer edges of the caves and all projecting points were graded away and brought to a slope 2:1, that the bank might present as even a surface as possible to the water flowing over it at higher stages. The surfacing of stone was made very heavy, each stone being carefully placed in position. The revetment was brought to the 20-foot contour above low water.

These repairs were begun November 1, and were completed November 20, when the quarterboat and force of 40 men which had been employed were removed to Twin Hollows, west bank.

When this work was first contemplated it was intended, in addition, to raise the stone-work immediately below this section of the bank from

14 feet, to which it has been completed, to 20 feet above low water, and to thoroughly protect with stone from the edge of the low-water mattress to the latter height the section of bank lying between the down-stream end of the 14-foot stone-work and the head of the primary hurdle at Pulltight, but owing to the shortness of the season and the scarcity of laborers at the west bank it was decided to postpone this work, which was not of immediate necessity, and to transfer the force to the west bank.

In the repairs indicated 2,828 cubic yards of earth was graded from the bank, and 61,268 square feet of the bank was revetted with 2,058.41 cubic yards of new stone, and 10,000 square feet additional was revetted with stone removed from the bank and replaced.

West Bank.—The work at this point consisted in the revetment of the artificial bank which had been formed by accretion works. The river showing a tendency to cave the bank at the head of the work, it was determined to revet this portion. This erosion had been going on for over a year, and is due to the growth of a bar on the west side of the lower end of Carroll's Island, which throws the current of the river against the Twin Hollows hurdles. To stop this erosion it was determined to revet the bank thoroughly, beginning at the head of the works and working down-stream as far as the short season would permit.

The necessary plant, consisting of quarterboats, waysbarge, pile-driver, etc., which had been in use at Cairo, Ill., was brought to Twin Hollows October 24, and the construction of a low-water mattress was at once begun. The head of the mattress was located immediately below the wreck of the old crib-work and against the bank 200 feet inside the line of the primary hurdle. It followed the bank closely at distances varying from 200 feet to 300 feet from the primary line, and finally crossing outside of that line at secondary hurdle No. 1, came to an end 100 feet below the latter hurdle. The mattress was completed November 29. It was of the usual type, 120 feet in width, and with a total length of 2,633 feet. No especial difficulty was encountered ether in constructing or sinking it, although at times a want of a sufficient number of laborers and the sharp curves about the ends of secondary hurdles Nos. 0 and 1 and in the deep recesses in the bank somewhat delayed the construction. The maximum day's work was 153 linear feet, and the average about 94 feet for the season.

On November 22 a quarterboat and force of men, which were brought from east bank, began grading and riprapping the bank above the shore edge of the mattress, and at the end of the season had completed the revetment on 800 linear feet of the bank, and partially completed it for 250 feet further, or to a point 230 feet above secondary hurdle No. 0. In addition, stone was placed for 100 feet around the end of hurdle No. 0, and extending from the mattress about half-way to the top of the bank. The stone-work began on the upper side of the old cribs, at the head of the primary hurdle. It extends from the mattress, 4 feet above low water, to the top of the bank, which is here from 18 to 20 feet above that level.

In placing the riprapping the stone was laid on the bank, beginning at the low-water mattress, and extending as far as the natural slope remained 2:1 or less. Above that the bank was graded to the slope 2:1, the earth being thrown out over the stone first laid, and the riprapping was then carried to the top of the grade, the stone being placed on the hard, compact bank.

In all, 45,000 square feet of bank was revetted with stone and 1,400 cubic yards of earth was graded away.

All work was suspended December 2 on account of the extreme cold weather. The heavy ice then running in the river prevented an immediate removal of all plant to the winter harbor at Bushberg, and it was not until December 8 that this was accomplished.

Although the season was very short—about five weeks—it was very favorable to the prosecution of the work, the river remaining throughout that time at a remarkably low stage.

This work, in connection with the works at Pulltight and Beard's Island, has resulted in giving a good navigable channel, with a least depth of 8 feet. The channel is somewhat tortuous, making a rather abrupt crossing at Pulltight, but it is probable that this will be rectified when the river has asssumed its stable direction.

Plate No. 3 shows the condition of the work on June 30, 1887.

CHESLEY ISLAND.

The work at this locality consisted in closing a break made by the ice and drift in the hurdle constructed in 1885 for the purpose of closing the chute between the island and the west bank of the river. The break of 170 feet in length, near the middle of the hurdle, was closed; the drift, which collected in large quantities against the piles, was loaded with stone sufficient to sink it to the bottom, and an extra row of piles was driven across the chute, just above the hurdle, to protect it from drift during high-water periods.

The following table gives the amount of work done:

Kind of work.	Number.	Linear feet.	Square feet.
Piles driven	253	.....	.....
Braces placed	42	.....	.....
Stringers placed	46	.....	.....
Foundation-mattress sunk	.....	530	42,100
Drift-mattress sunk	.....	465	17,900
Revetment placed	.....	200	10,000
Wattling placed	.....	30	180

The piles were driven above the line of the old hurdle, as the water through the break and below it was considerably deeper than the water above it. Three rows were driven, 18 feet apart, the ends of the hurdle extending 30 feet beyond the break, with the brace-piles close to the drift row of the old hurdle. The piles in the drift row were driven double every 12 feet, the hurdle-piles were driven every 6 feet, and the brace-piles 12 feet apart.

Longitudinal stringers were placed on each row at the 16-foot stage, with cross stringers every 12 feet, bolted to the longitudinal stringers. Braces were placed against every drift and every other hurdle-pile, all of them hung with clevises to the row below. The upper end of the brace was framed to the pile and secured to it by a three-fourths inch screw-bolt.

The foundation-mattress was woven on way flats in the usual manner. It was built the full length of the hurdle, 50 feet in width, extending 15 feet above the drift row and 5 feet below the brace row. A mattress was also constructed and placed in the break to prevent further scour. It was 230 feet long by 110 feet in width, completely covering the entire surface of the break, with the ends lapping on to the foundation mattress of the old hurdle. A rise in the Meramec River brought a large field of drift against the hurdle just after the founda-

tion mattress was placed. A mattress from 35 to 40 feet in width, consisting of a double layer of brush, wired to poles placed 6 feet apart, was built on the drift around the new work with the ends resting on the old hurdle. Stone to the amount of 788 yards was put on this mattress, sinking the drift to the bottom, forming a solid protection up to the 11-foot stage for the new work. For a high-water protection against drift a row of piles was driven about 75 feet above the floating drift, clear across the chute, with the top of the piles left at the 22-foot stage 6 feet higher than the hurdle. They were driven in clumps, about 16 feet apart, with three piles to a clump, the down-stream pile about 6 feet below the others and bolted to them by 1-inch screw bolts.

A slight scour in the revetment at the island end of the hurdle was repaired, and an extra layer of stone was spread over it for a length of 200 feet by 50 feet in width.

The drift-row of the hurdle, at the island end, was extended 50 feet nearer the shore and wattling placed on it as high as the stringer for a length of 30 feet, with the shore ends of the brush resting on the revetment and held in place by a layer of stone.

The season's work began April 13 and closed June 20, during which time the maximum force employed was 58.

Plate No. 3 shows the condition of this work on June 30, 1887.

The result obtained by this work is not yet demonstrated and can not be stated until the next run out of ice and high water. The effect of the work as a whole, since its conception, has been a decided fill in the chute, and will no doubt result finally in closing it.

JIM SMITH'S.

The only work done at this locality was the wattling of hurdle lines Nos. 6, 6½, 7, and 7½, from the 8-foot to the 16-foot stage, and the repairing of the wattling on No. 5½.

The amount of wattling placed on each hurdle is shown in the following table:

Hurdle line.	Linear feet.	Square feet.
No. 5½	1,000	3,025
No. 6	726	5,077
No. 6½	775	6,134
No. 7	728	6,012
No. 7½	925	8,025
Total	4,154	28,273

The brush used in wattling these hurdles was landed by the steamer *Gen. Gillmore* at the river end of No. 7½, and from there it was hauled by teams over the bar to the different hurdles as required.

Lines Nos. 6, 6½, 7, and 7½ were wattled in the order named, from the 8-foot stage, or from the surface of the bar, where the wattling previously placed was covered, to the hurdle stringer. For a distance of 155 feet on Nos. 6 and 7 the bar had formed up to the hurdle stringer.

Line No. 5½ was wattled in 1885 from the bar, which had raised to the 11-foot stage, 3 feet above the wattling placed when the hurdle was constructed, to the hurdle stringer, but during the high-water period, in the spring of 1886, the bar scoured from between the wattling, leaving a gap 1,000 feet long.

The brush remaining on hand after wattling the lower lines was used in closing this gap. The results obtained from this work have been entirely satisfactory, a large fill has been obtained, and will continue to increase. This is shown on Plate No. 3.

SULPHUR SPRINGS.

The plan for the improvement comprises a secondary hurdle every 1,000 feet from the shore to the river line E. D. C. B. (Plate No. 3), which extends from the foot of Jim Smith's to the head of Foster's Island.

Eight hurdles were constructed, Nos. 1, 3, 4, and 5 in the fall season of 1886, Nos. 6, 7, 9, and 11 in the spring season of 1887. Nos. 2, 8, and 10 were omitted. The amount of work done on each hurdle is given in the following table:

No. of hurdle.	Designed length of hurdle from bank to river line.	Piles driven.			Stringers.		Braces.	
		No.	Depth driven.	Linear feet of line.	No.	Linear feet of line.	No.	Linear feet of line.
1	1,165	538	8,406	1,290	170	1,290	285	1,290
3	1,160	245	3,860	575	63	575	139	575
4	1,355	577	8,532	1,355	153	1,355	316	1,355
5	1,600	682	9,629	1,620	147	1,020	354	1,620
6	1,900	820	11,492	2,320	143	2,320	289	1,735
7	1,920	773	10,974	2,120	200	2,120	337	1,950
9	2,220	690	9,140	2,130	116	2,130	368	2,130
11	2,550	687	9,312	2,550	178	2,550	424	2,550
Total	13,870	5,012	71,345	13,960	1,101	13,960	2,512	13,205

No. of hurdle.	Mattress.		Wattling.		Revetment.		Length of hurdle in good order June 30, 1887.
	Linear feet.	Square feet.	Linear feet.	Square feet.	Linear feet.	Square feet.	
1	1,220	92,720	1,290	20,800	200	15,000	1,215
3	540	43,200	575	13,500	200	11,000	575
4	1,300	98,800	1,355	30,000	200	13,000	1,290
5	1,560	121,800	1,620	39,290	200	15,000	1,600
6	1,865	156,025	1,450	31,100	200	9,000	1,680
7	2,090	189,550	1,600	28,920	200	10,800	1,870
9	2,130	181,050	1,585	40,760	200	12,600	2,080
11	2,550	216,750	1,900	41,780	200	12,000	2,550
Total	13,255	1,099,895	11,375	247,140	1,600	98,400	12,860

Driving of hurdle No. 1, the same as No. 9 of Jim Smith's, was the first construction work done at Sulphur Springs. It was begun October 1, and driven a length of 1,220 feet, 100 feet beyond the river line. No. 3 was driven 540 feet from shore, leaving 600 feet undriven. No. 4 was driven full length, 1,300 feet, and No. 5 1,200 feet, 340 feet inside the river line.

Three rows of piles, from 18 to 20 feet apart, were driven in each hurdle, with the piles spaced 6 feet apart in the drift and hurdle rows and 12 feet in the brace row. Six drivers were in service a total of 1,232 hours, driving 1,834 piles a depth of 27,516 feet, an average of 1.49 piles per hour, with a depth of 15 feet for each pile driven. With shoal water and a slow current the driving was easier than usually found on contraction works.

A foundation-mattress was constructed and placed the full length of each hurdle, with an average width of nearly 80 feet, the mattress extending 15 feet above the drift-row and 25 feet below the brace-row. It was woven on flats fixed with ways, two flats being placed above the drift-row, one between the drift and hurdle rows, one between the hurdle and brace rows and three below the brace-row. The mattress was made continuous the full length of Nos. 1 and 3, and with only one break in Nos. 4 and 5.

The hurdle-stringer was placed at the 16-foot stage, the height to which the hurdles were constructed. A double row of drift-stringers was placed, one at the 6-foot stage and one at the 17-foot stage. The drift-stringers were placed by hand, the upper from a barge, on which was loaded each time piles sufficient for a hurdle, the lower from a flat with fixed trestles on it holding the piles at the 6-foot stage. To strengthen the river ends of the hurdles cross-stringers reaching from the drift to the brace row were placed every 12 feet for a distance of 636 feet on No. 1, 120 feet on No. 3, 372 feet on No. 4, and 108 feet on No. 5; each cross-stringer being bolted to the drift-stringer, the hurdle-stringer, and to the brace-pile. Screw-bolts 1 inch in diameter were used in bolting all the stringers.

Both the drift and hurdle rows were braced. The drift-row braces were spaced 6 feet apart, with the bottom of the brace secured to the hurdle-pile by a clevis, and the top framed to the drift-pile, every other one to the height of the upper stringer and half to the lower stringer. The hurdle braces were spaced 12 feet apart, with the bottom secured to the brace-pile and the top framed to the hurdle-pile. Flats with platforms at a height convenient for working at the 6 and 16-foot stage were used in framing, which consisted of fitting the brace to a shoulder cut 1½ inches deep in the pile just below the stringer and bolting the brace to the pile with a ¾-inch screw-bolt. The clevises were made of 1-inch iron for the river ends of the hurdles and ¾-inch iron for the shore ends.

Wattling was placed on the hurdle-row the full length of each hurdle from the mattress to the 8-foot stage. The portion below the water was woven in courses of 1 foot in height, tied together where the brush crossed between the piles with wire or sisal yarn, and pushed to the bottom with hurdling-forks. Above the water each piece of brush was woven to its place separately, with the butts on the down-stream side fastened to the pile by 20*d*. nails.

To protect the bank at the shore end of the hurdles, riprap was placed from the mattress to the top of the bank for a distance of 100 feet above and below each hurdle-row.

The order of construction for hurdles Nos. 1, 3, 4, and 5 was as follows: Driving, mattress construction and sinking, drift-row stringing, drift-row bracing, hurdle-row stringing, wattling, hurdle-row bracing, cross stringing river ends, and the placing of riprap any time after the mattress was sunk.

The construction work was suspended November 29. The maximum force employed at any one time was 278. Eleven portable buildings were erected for quarters on the bank just below No. 5. The roofs of the buildings were re-covered with canvas and painted, their erection and painting occupying the time from September 30 to October 9.

The damage to the hurdles by ice during the winter was very small. The drift-row of No. 1 was broken in several places and 75 feet carried away from the river end. A few piles were broken at the ends of Nos. 4 and 5.

The first work done on the resumption of work, March 21, was the closing of the gaps at the shore end of Nos. 1, 3, 4, and 5, the higher stage of the river permitting the extension of No. 1 70 feet nearer the bank; No. 3, 35 feet; No. 4, 55 feet; and No. 5, 60 feet. Work on hurdles Nos. 6 and 7 was started March 23. The driving of No. 6 was nearly completed, with the other work well up, when a rapid rise in the river carried away 400 linear feet of piling from the river end with 150 linear feet of floating mattress. The wreck of No. 6, with two brush-barges and several mattress-flats, lodging on the end of No. 7, carried away 250 feet of piling and 90 feet of floating mattress. Driving on Nos. 9 and 11 was then begun, and their construction carried full length without trouble—No. 11 to the river line, a length of 2,550 feet; No. 9, 2,130 feet, 100 feet inside of the line, where it was stopped, owing to its encroachment on the steamboat channel. Driving on No. 7 was then resumed and the hurdle extended to the river line, a length of 2,130 feet. No. 5 was also driven from the end of last fall's work to the river line, an extension of 340 feet. After No. 5 was completed, the river end of No. 6 was again driven nearly to the line, when a rise in the river carried away 185 feet of piling, but without damaging the floating mattress inside of it or the hurdle below.

The order of construction and also the form of the hurdle was somewhat changed from that of last fall. (See Plate No. 5.)

The drift-piles were driven 12 feet apart, and for a distance of 300 to 700 feet. At the river ends they were driven double, the lower one from 2 to 4 feet below the upper one, and both bolted to the drift-stringer. Only two rows, the drift and hurdle, were driven in Nos. 9 and 11, and the river ends of Nos. 5, 6, and 7.

Stringers were placed on both hurdle and drift rows at about the 16-foot stage. The drift stringers were generally placed while the foundation mattress was floating, but at the river ends of Nos. 6 and 7 it was found necessary, on account of the strong current, to place the drift and also the hurdle stringer as the piles were driven, in order to hold them in position. Cross stringers reaching from the drift to the hurdle row were placed every 12 feet on No. 6 for a length of 250 feet from the river end. A double row of cross stringers was placed on 800 linear feet of the river end of No. 7, one every 36 feet, bolted to the drift and hurdle stringers, and one every 24 feet, placed at the 9-foot stage, bolted to both piles and to both of the braces. Braces were placed every 12 feet against the drift and hurdle rows. In the hurdles having only two rows of piles the hurdle-row brace was driven in the line of the undriven-brace row from 6 to 8 feet through the mattress, then pulled over to the hurdle stringer and bolted to it and to the hurdle pile. Most of the drift braces were hung with clevises to the hurdle piles, but a large number, especially at the shore end of Nos. 9 and 11, were driven through the mattress alongside the hurdle pile and pulled over to the drift row.

Where the brace row was omitted an extra flat was used in the construction of the mattress, two being placed above the drift row, one between the drift and hurdle row, and five below the hurdle row. In the strong current at the end of the hurdles the up-stream edge of the mattress was stiffened with heavy poles, wired to it every 12 feet, to prevent the mattress from breaking along the drift row while sinking it. The wattling on the upper hurdles, Nos. 1, 3, 4, and 5, was raised from the 8 to the 16 foot stage. On Nos. 6 and 7 wattling was carried full height, from the shore end, for a length of 900 feet on No. 6, and 1,150 feet on No. 7. Curtain mattresses were used in place of wattling

on the river ends of Nos. 5, 6, and 7. They were made in lengths of 100 feet, by a width of 12 to 20 feet, so that the upper edge of the mattress when launched against the drift row was at the 10-foot stage. These mattresses on No. 5 were placed on the new work to the river line for a length of 500 feet beyond the wattling on No. 6, and 400 feet on No. 7. On No. 9 the wattling was carried full height, 1,200 feet from shore, and 385 feet beyond, only to the 10-foot stage. On No. 11 the wattling was carried full height a length of 1,900 feet. The large amount of drift accumulated on Nos. 6, 7, 9, and 11 prevented the extension of the wattling to their river ends.

The shore ends of Nos. 6, 7, 9, and 11 were protected with riprap, No. 6 only to the 16-foot stage, the others to the top of the bank.

The maximum force employed was 430. Upon the closure of the works, June 25, all the plant was transferred to the fleet at Bushberg.

The scour caused by the strong current passing under the drift, which collected on the river end of the hurdles during June, carried away 65 feet from the end of No. 4, 20 feet from No. 5, and 50 feet from Nos. 9 and 11. About 100 feet of drift row was broken on the end of Nos. 5, 7, and 9, without breaking the hurdle-row.

Plate No. 3 shows the condition of the work on June 30, 1887.

The effect produced by the works at Sulphur Springs has been, for the portion constructed last fall, a large deposit of material. The effect of the work done during the spring is not yet very apparent, as it is too recent to have as yet produced much effect; but it will without doubt, as in all similar cases, produce the desired result of narrowing the river to the required width of 2,500 feet.

CAIRO BANK PROTECTION.

Special mention of this work, with an allotment for its prosecution, has been made in the river and harbor appropriation bill, the allotment coming out of the amount appropriated for the improvement of the Mississippi River, between the Illinois and Ohio Rivers. The object of the work is the protection of the bank of the Mississippi River at Cairo, where a cut-off into the Ohio River was threatened.

An examination of this bank and the works executed for its protection was made July 22, 1886. The river, however, was at a stage marking 15¾ feet on the Cairo gauge, and exposed to view only the stone-work of the medium stage protection and those portions of the low-water mattress of 1884 which covered the spur-dikes. The stone-work was in excellent condition, very slight repairs, which could have been done by replacing the stone already there, being needed. Below the water-surface the work seemed equally good, as no evidence of a break or slip in the bank could be seen.

In September a force was organized and the plant made ready for work at Twin Hollows, but before beginning work it was transferred for duty at Cairo, in accordance with orders dated September 28. This change of plan was occasioned by the report of Mr. S. S. Taylor, of the Cairo Trust Property, dated September 27, on the probable settling of the longitudinal stone wall which connects the water ends of spur dikes Nos. 3 and 4. To repair the damage or correct such a tendency, it was thought necessary to place a mattress between these dikes outside of and overlapping the mattress of 1884, thus nearly doubling the width of the low-water protection at that place.

The steamer *Jack Frost* was chartered from the Huse and Loomis Ice Company, and, October 1, started from the harbor for Cairo, towing

the barges and material necessary for the construction of the mattress, and a barge loaded with stone to sink it. At Grand Tower forty men were discharged on account of refusing to coal the steamer. This seriously crippled the force and considerably delayed the work, as it was difficult to procure good laborers, and those who were hired were unaccustomed to the work. The fleet reached the foot of Power's Island October 4, and remained there until the 9th to procure brush for the mattress; 523.46 cords were cut and loaded on barges. While procuring brush the steamer proceeded to Cairo and an examination was made of the work in question. The lower half of the wall was found intact, and the upper half did not seem to have settled, but to have had the top destroyed by ice. About 20 feet of water was found on top of this portion of the wall in the deepest place. The spur dikes and the remainder of the revetment were in good condition. The water-surface marked about 7 feet on the Cairo gauge at this time, and afforded an excellent opportunity for an examination of the works. As it did not subsequently rise above that level, it was most favorable for the construction and placing of the mattress.

The fleet reached Cairo October 10, and work was at once begun.

As no further service was required from the steamer *Jack Frost* after reaching Cairo, it was dismissed and started for Saint Louis on the 11th. The mattress was constructed without difficulty, and was sunk into place October 20. It was 544 feet in length and 120 feet in width, and extended from the third to the fourth spur dike, lapping on the mattress of 1884 and completely covering the outer slope of the longitudinal wall.

In addition about 3,500 square feet of the riprapping was repaired by resetting the stone wherever it showed a break or tendency to slip. Most of this work was done on the spurs where the stone had been slightly displaced by ice.

All work was completed October 22, and the fleet removed to Twin Hollows, Westbank, by the steamer *General Gillmore*, arriving there on the 24th. Three empty barges were left at Cairo to await the second trip of the steamer, and were brought to Twin Hollows on the 29th.

Plate No. 4 shows the condition of the work on June 30, 1887.

This work has resulted in protecting the bank, and, in connection with the changes which have taken place in the river at this point, has resulted in preventing the threatened cut-off.

PIASA ISLAND.

Work at this point consisted in the washing out a channel through a bar which had formed below the opening made in the dam for a low-water channel. This was done by the towboat *General Gillmore*, at a small expense, the cost having been $366.75.

MATERIAL.

Brush.—The brush used in the construction was procured by hired labor from the banks or islands in the river wherever convenient, a royalty of 10 cents per cord being paid to the owners of the land from which it was obtained.

In the fall season a party, consisting of thirty-five men and six teams, was organized September 22, and commenced work on the Missouri shore below Fine's Bluff on the following day. This force was grad-

nally increased to the full capacity of quarterboat No. 7, and by the second week in October consisted of forty-five laborers and fifteen teams, with the usual complement of foreman and kitchen crew.

On October 19 it became necessary to increase this force to a double capacity for a short time, in order to supply sufficient material for the mattress work about to be commenced at Twin Hollows. Barge No. 12 was fitted out at the supply depot with portable quarters and a boarding outfit, and being received on the above date, the force was increased to one hundred men and twenty-four teams.

By November 1, a sufficient surplus having been procured, the force was reduced to about sixty men, with twenty teams, and maintained at about this status until the season's work was completed, November 25.

Brush was procured during the season at Fine's Bluff, Chesley Island, Jim Smith's, Arsenal Island, Carrall's Island, and Beard's Island, and all the available brush procured at each of these localities, except a small amount on Carrall's and Beard's islands.

The weather during the entire season was very favorable, not more than four days being lost on this account.

The small amount which could be procured at each locality, necessitating the moving of the plant six times in a season of nine weeks' work, rendered progress slower than it would otherwise have been. The amount procured was 5,144.4 cords.

In the spring season the active work of procuring brush was commenced on March 16 at Foster's Island. Previous to this time a few men had been employed several days at Bushberg Harbor, preparing the quarters for occupancy and getting the plant ready for active work. On the 16th a force of fifty laborers and twelve teams, and the usual foreman and kitchen contingent, was employed.

The force was kept at about this capacity until April 25, when the force was reduced about one-third, as there was quite a surplus of brush on hand. From this date until the close of the season's work, June 10, the force of laborers averaged about thirty men, the proportion of teams varying from ten to twenty, according to the length of haul. Brush was procured at four localities, viz: Foster's Island, Calico Island, Rush Tow-head, and Harrisonville Bend. At the last-named locality, where the season's work ended, the haul became very long, being between 1½ and 2 miles. Some available brush remains at this locality, and also a small amount on Calico Island.

The weather was quite favorable, for, although considerable time was lost on account of rain, the roads over which the brush was hauled did not at any time become as heavy and impassable as is usual in the spring season.

The amount procured was 5,799.1 cords, making the total procured during the fiscal year 10,943.5 cords.

Stone was obtained from the Glenwood Lime and Quarry Association at a cost of 47⅞ cents per cubic yard. *Piles* were obtained by contract from Mr. John Cleary. *Rope, spikes, iron, nails, and screw-bolts* were obtained by contract with different parties. Other material, as needed, was obtained on bids or by purchase in open market.

Abstracts of all the bids received on formal contracts during the fiscal year are appended, and marked Appendix C.

Subsistence stores were purchased in quantities as required, a supply sufficient for fifteen days being purchased at one time, except fresh meat, which was delivered as required. The cost of subsistence was 37 cents per man per day.

SUPPLY DEPOT.

The supply depot was under the immediate charge of Mr. C. L. Stevenson; the subsistence department under the direction of Mr. S. S. Van Norman. All supplies, except brush, stone, and piles, as obtained, were delivered at the depot and thence distributed on requisition to the different works. In addition to this function of the depot, it was also a general repair-shop, where all repairs to plant not requiring dockage were made. During the season 18 pile-divers were thoroughly overhauled and repaired; 12 barges, 2 quarter-boats, 1 machine-shop, 1 mattress-barge, 77 flats, 52 skiffs, and 36 yawls were repaired. The plant is now in a good condition for resuming operations.

The present valuation of the property remaining to be distributed on installation account is given in the following table:

Class of property.	Balance July 1, 1886.	Debits.	Credits.	Balance June 30, 1887.
Barges, model, and flat	$66, 292. 91	$12, 751. 80	$20, 226. 34	$58, 818. 37
Boat, machine-shop	1, 535. 21	480. 49	531. 44	1, 484. 26
Boats, quarter	1, 387. 98	983. 49	594. 32	1, 777. 15
Drivers, pile	26, 358. 17	18, 860. 57	8, 751. 74	36, 467. 00
Flats	3, 995. 85	2, 543. 14	1, 669. 86	4, 869. 13
Machinery, steamer *Humphreys*	6, 000. 00	370. 61	370. 61	6, 000. 00
Shanties, portable	16, 324. 03	2, 472. 22	4, 491. 25	14, 305. 00
Skiffs	668. 60	770. 38	716. 45	722. 62
Steamer *General Gillmore*	16, 592. 32	16, 917. 07	17, 462. 44	16, 046. 95
Tents	264. 04	.....	52. 99	211. 95
Ways for mattress	1, 165. 85	527. 61	608. 76	1, 084. 70
Yawls	1, 127. 21	339. 21	600. 58	865. 84
Supply depot	3, 395. 95	333. 81	978. 76	2, 751. 00
Tools and appliances	1, 260. 99	1, 497. 28	1, 117. 44	1, 640. 83
Boarding outfit	13, 575. 89	1, 127. 51	2, 326. 00	12, 377. 40
Office furniture	625. 62	.....	118. 87	506. 75
Surveying instruments	760. 84	14. 80	159. 33	616. 31
Photographic apparatus	275. 00	.....	52. 25	222. 75
Total	161, 607. 45	59, 989. 99	60, 829. 43	160, 768. 01

GAUGES.

The gauges at Grafton and at Gray's Point were read daily during the season. The readings are appended, marked "D."

CONDITION OF THE RIVER.

The channel depths, as furnished by the St. Louis and New Orleans pilot association during the low-water season, are appended, marked "E."

The low-water season extended from the middle of July, 1886, till the close of navigation by the ice on January 1, 1887.

The least depth reported was 4½ feet; this was found at Apple Creek on September 2, 1886, the gauge-reading at Saint Louis the same day being 1.9 feet above standard low water. A depth of but 5 feet was found at Liberty Island and Dog-Tooth Bend. The least channel depth reported in the improved portion of the river between Saint Louis and Sulphur Springs, a distance of 24 miles, has been 8 feet, thus the desired result for this portion of the river has been arrived at; the depth here before the work of improvement was begun was frequently as small as 4½ to 5 feet.

The following extracts, taken from the annual statement of the Merchants' Exchange of Saint Louis for the year 1886, is given in this connection:

* * * * * * *

Formerly the river between Saint Louis and Cairo offered the greatest obstructions to navigation southward on account of Horse-Tail and Twin Hollows Bars, the former 5 miles and the latter 19 miles below Saint Louis. Since the improvement of these bars the channel out to Cairo has averaged 10 to 20 feet, except, as before stated, in extreme low water, enabling the southern packets and the barge line to load to their full capacity. As elsewhere stated, during the latter part of the past season, when the stage of water was unusually low, the water on these bars was 3 to 4 feet deeper than at some other points, and had these improvements not been made these bars would have virtually made navigation southward impossible.

* * * * * * *

During the year 1886 the amount of freight in tons received at and shipped from Saint Louis by the river was as follows:

	Received.	Shipped.
	Tons.	*Tons.*
Lower Mississippi River	140,880	46,190
Upper Mississippi River	173,610	431,945
Illinois River	88,010	5,175
Missouri River	82,620	24,255
Ohio River	116,885	26,060
Cumberland and Tennessee rivers	18,200	25,075
Red and Ouachita rivers	.....	3,195
Total, 1886	570,205	561,895
Total, 1885	479,065	534,175
Total, 1884	520,850	514,910

While the railroads have absorbed to a great extent the carrying trade of the country, it is an admitted fact that the Great Lakes and the Mississippi River and its tributaries exert a powerful influence as arbiters of freight rates.

* * * * * * *

The stage of the river was unusually low, there being no June rise, and from June 1 to December 31 was lower than perhaps ever before during the same months. The benefits of the work done by the Government, under the direction of Maj. O. H. Ernst, in improving the river, was practically demonstrated during the year, as pilots reported 3 or 4 feet more water at points where the work had been carried on than at other points.

ESTIMATE.

The amount which can be profitably expended during the year ending June 30, 1889, is $1,000,000. It is proposed to expend it in carrying out the programme heretofore adopted. This is, to first improve the part of the river below Saint Louis, to make the improvement continuous, beginning at Saint Louis and working down-stream, reclaiming land and building up new banks, thus reducing the river to the approximately uniform width of about 2,500 feet. Alluvial banks are to be protected from erosion. It is proposed by this means to secure a channel depth of at least 8 feet at the lowest stage. The depth is now liable to become as little as 4 feet, or even less in some places, and less than 8 feet in every place where the width is greater than 2,500. This general statement of the proposed application of the appropriation is as specific as the nature of the case will admit of. The changeable character of the river renders it impracticable to give in advance the exact localities where works will be required.

The original estimated cost of this work, as revised in 1883, was.....	$16,997,100.00
The aggregate amount appropriated to June 30, 1887, is.....	3,739,600.00
The amount expended to June 30, 1886, is	3,328,431.87

Money statement.

July 1, 1886, amount available		$41,309.65
Miscellaneous receipts		1.88
Amount appropriated by act approved August 5, 1886		375,000.00
		416,311.53
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$193,076.63	
July 1, 1887, outstanding liabilities	7,061.88	
		200,138.51
July 1, 1887, amount available		216,173.02
Amount (estimated) required for completion of existing project		13,257,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

CONSTRUCTION ACCOUNT.

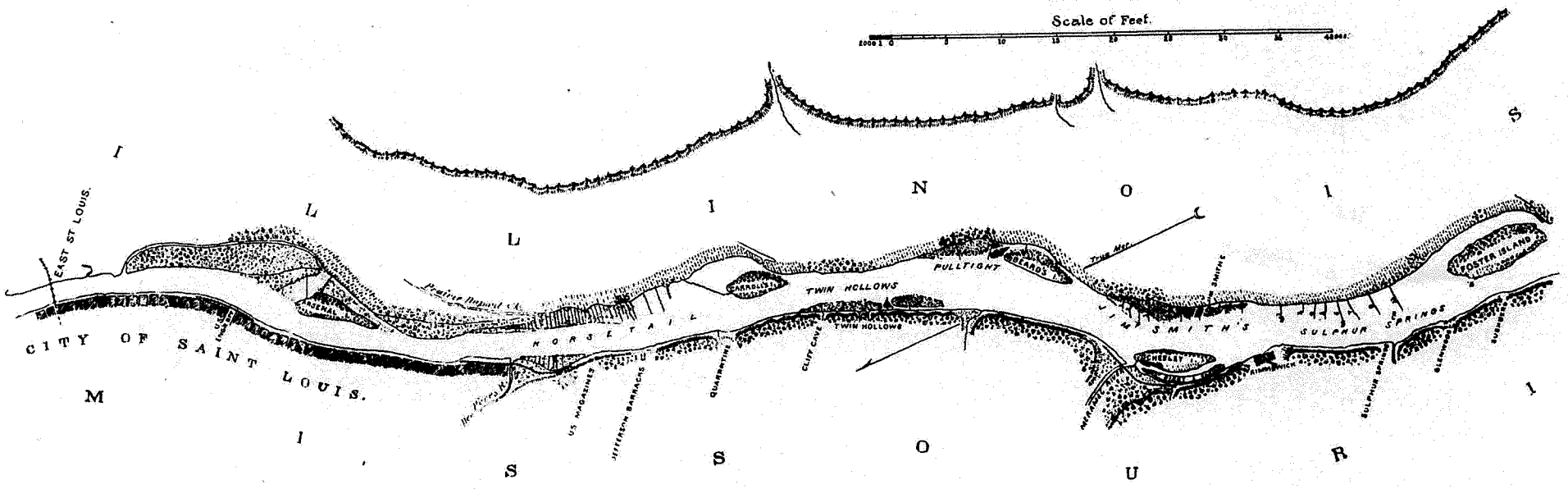
Name of work.	Expended prior to July 1, 1886.	Expended during fiscal year ending June 30, 1887.	Total cost to June 30, 1887.
Piasa Island:			
Dam	$32,333.30		$32,333.30
Dam (cutting channel)	2,750.11	$366.75	3,116.86
Alton Dam	33,623.92		33,623.92
Alton Dike	76,652.74		76,652.74
Sawyer Bend protection	96,803.63		96,803.63
Venice Dikes	36,341.85		36,341.85
Arsenal Island protection	42,599.06		42,599.06
Closing Cahokia Chute	119,958.21		119,958.21
Channel opposite Saint Louis	58,455.54		58,455.54
Horsetail Bar:			
Dike 1	40,549.53		40,549.53
Dike 2	23,600.26		23,600.26
Dike 3	82,602.54		82,602.54
Dike 4	41,290.11		41,290.11
Dike 5	36,933.87		36,933.87
Training-wall	80,627.03	626.25	81,253.28
Hurdles	539,582.67	9,251.41	548,834.08
Bank protection	40,993.55		40,993.55
Twin Hollows:			
West side, hurdles	248,837.82		248,837.82
West side, bank protection		19,161.31	19,161.31
East side, bank protection	125,459.57	3,460.73	128,920.30
Beard's Island:			
Primary hurdle	7,166.24		7,166.24
Bank protection	84,258.76		84,258.76
Jim Smith's hurdles	306,523.83	2,590.63	309,114.46
Pulltight	123,600.40		123,600.40
Chesley Island:			
Bank protection	64,416.04		64,416.04
Hurdles	18,691.06	9,117.55	27,808.61
Sulphur Springs hurdles		152,717.26	152,717.26
Foster's Island	44,296.02		44,296.02
Fort Chartres Dam	36,812.86		36,812.86
Turkey Island	24,463.85		24,463.85
Kaskaskia protection	66,465.62		66,465.62
Liberty Island:			
Dam	5,053.91		5,053.91
Protection	45,129.40		45,129.40
Devil's Island:			
Dike 1	65,871.17		65,871.17
Dam 1	49,848.58		49,848.58
Dam 2	16,678.30		16,678.30
Minton Point hurdles	33,436.37		33,436.37
Cape Girardeau, primary hurdle	31,930.18		31,930.18
Cairo protection	152,394.31	8,045.51	160,439.82
Expense of Board on bridge at Chain of Rocks		231.76	231.76
Survey		1,941.35	1,941.35
Total	2,937,122.21	207,510.51	3,144,632.72

Improvement of Mississippi between Illinois and Ohio Rivers. Annual Report of Major A.M.MILLER, Corps of Engineers. 1887.

PLATE I.

MAP OF
MISSISSIPPI RIVER
FROM
SAINT LOUIS BRIDGE TO FOSTER ISLAND
Showing location of works of improvement.

Scale of Feet.



Improvement of Mississippi between Illinois and Ohio Rivers. Annual Report of Major A. M. MILLER, Corps of Engineers. 1887.

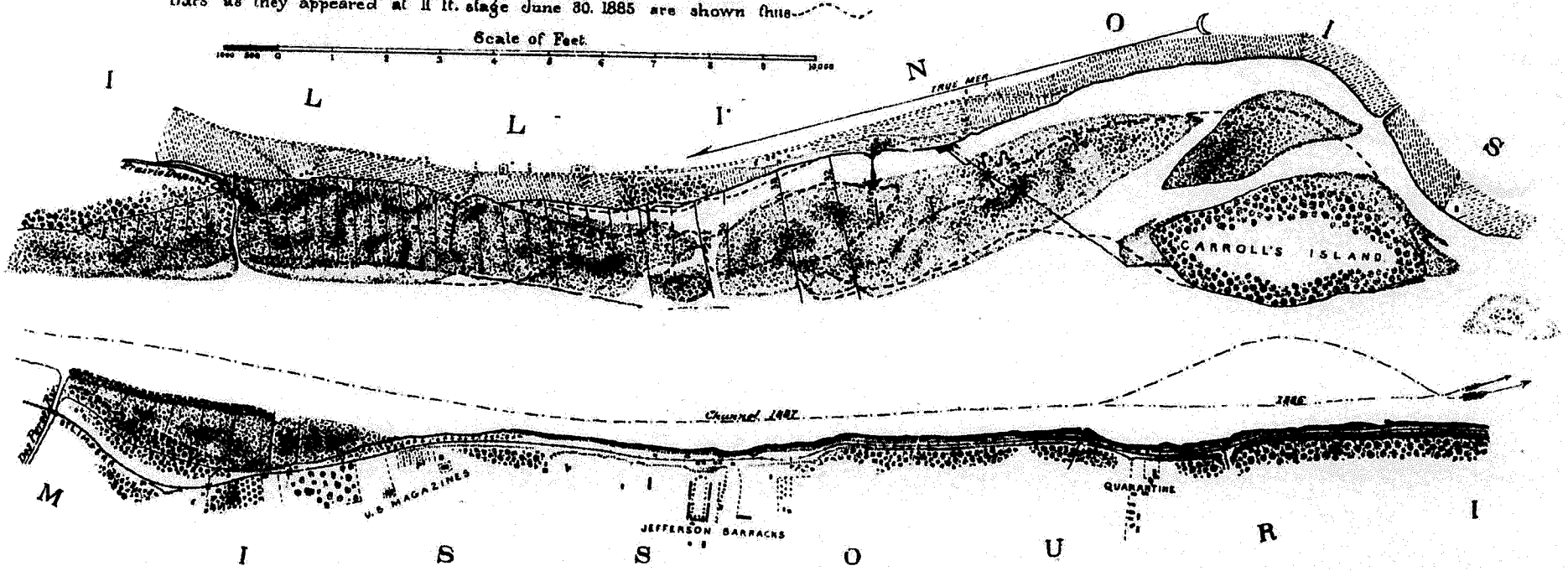
MISSISSIPPI RIVER.
HORSETAIL.
Map showing condition of works June 30th 1887.

Bank protection, west side, represented thus

Bars are shown as they appear at stage 11 ft. above standard low water.

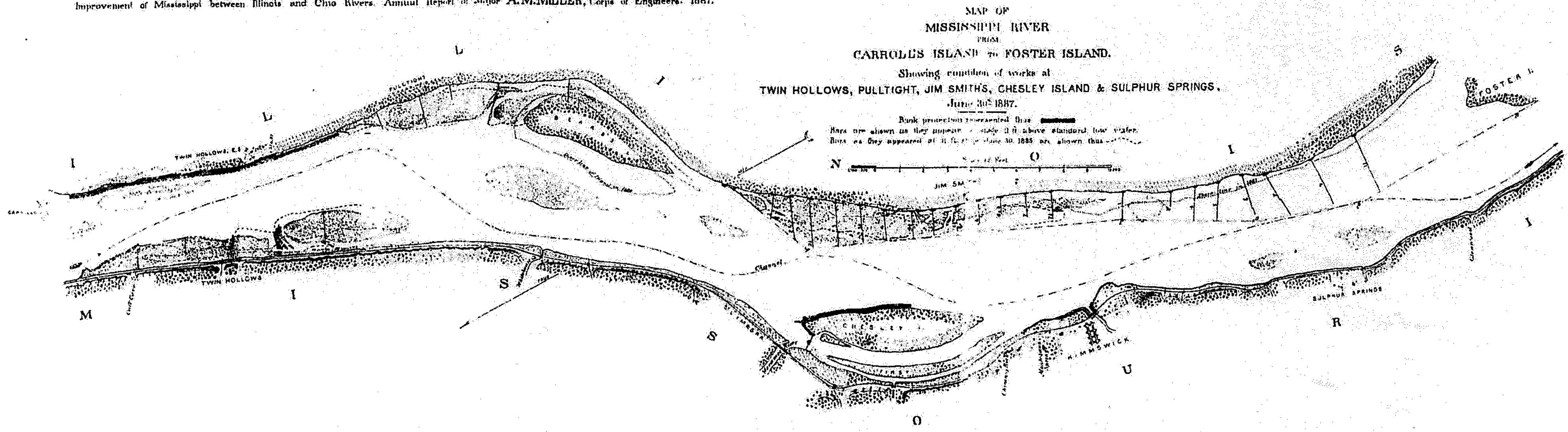
Bars as they appeared at 11 ft. stage June 30. 1885 are shown thus

Scale of Feet.



Standard low water is 4 ft. above 0 of St. Louis Gauge.

PLATE III.

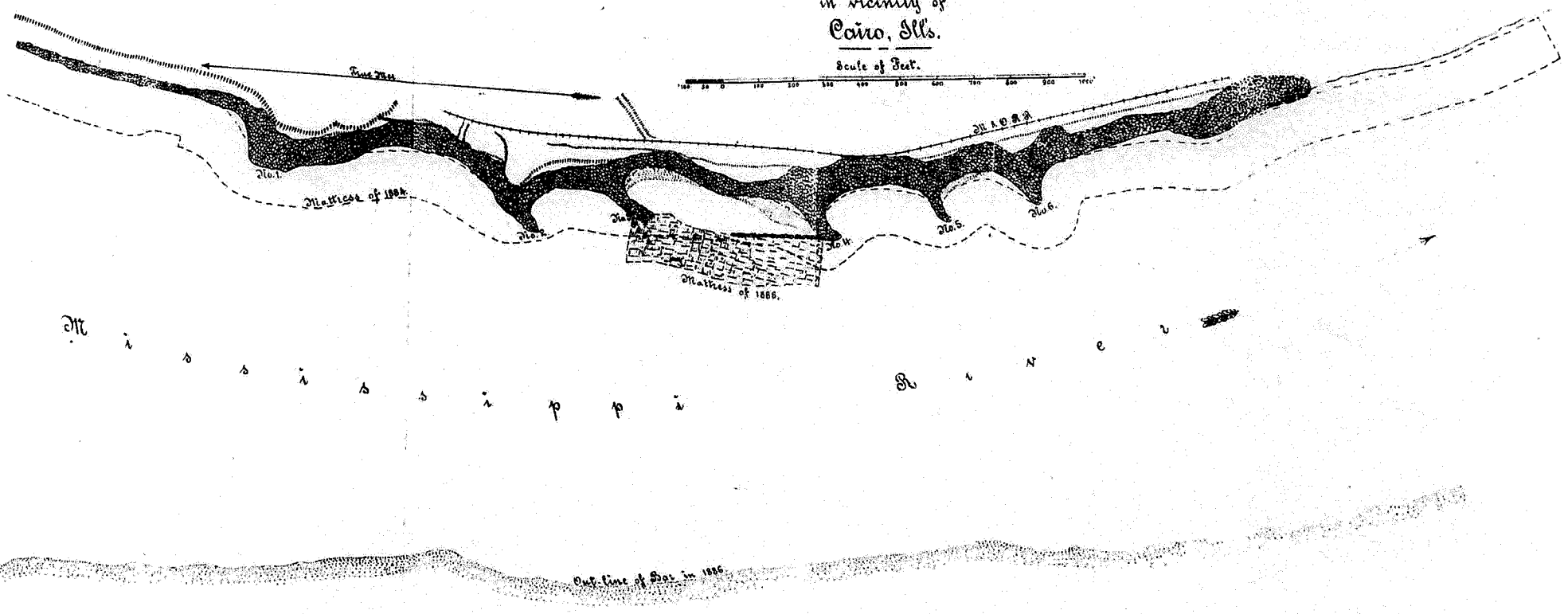

MAP OF
MISSISSIPPI RIVER
FROM
CARROLL'S ISLAND TO FOSTER ISLAND.
Showing condition of works at
TWIN HOLLOWS, PULLTIGHT, JIM SMITH'S, CHESLEY ISLAND & SULPHUR SPRINGS.
June 30th 1887.
Bank protection represented thus
TWIN HOLLOWS
CHESLEY I.
KIMMSWICK
SULPHUR SPRINGS
FOSTER I.
JIM SM
Channel
I L L I N O I S
M I S S O U R I

Annual Report of Major R. M. Miller, Corps of Engineers. 1887.

PLATE IV.

N-4.

Sketch of Bank Protection, in vicinity of Cairo, Ills.



2535

Improvement of Mississippi River between Illinois and Ohio Rivers.

Forms of Bundles.

PLATE V.

Scale of Feet.

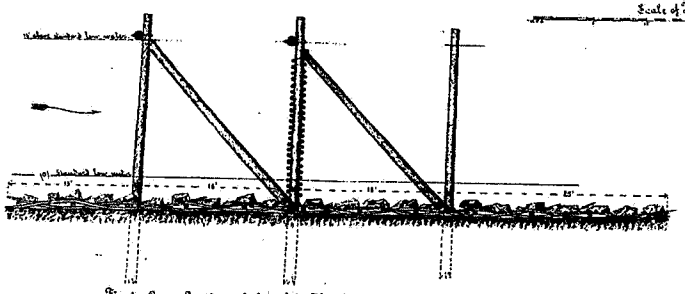


Fig. 1. Cross Section of finished Bundle. Normal Type.

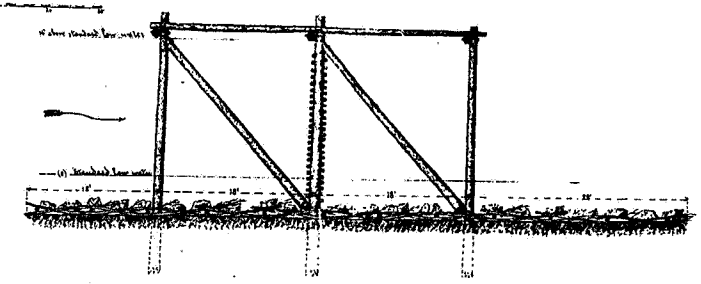


Fig. 3. Cross Section of finished Bundle in swift current or depths greater than 18 feet.

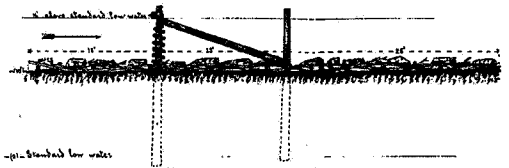


Fig. 2. Cross Section of Bundle in depths of from 3 to 6.

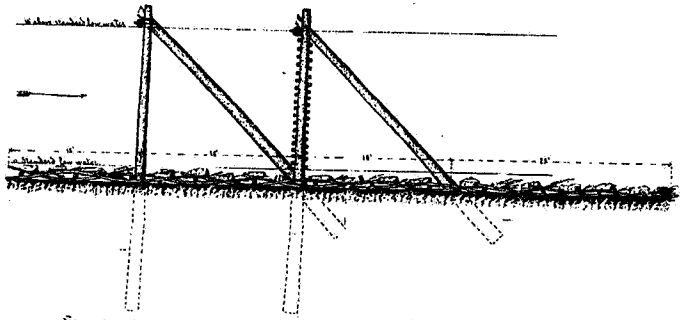


Fig. 1.bis. Cross Section of finished Bundle. Normal Type as modified.

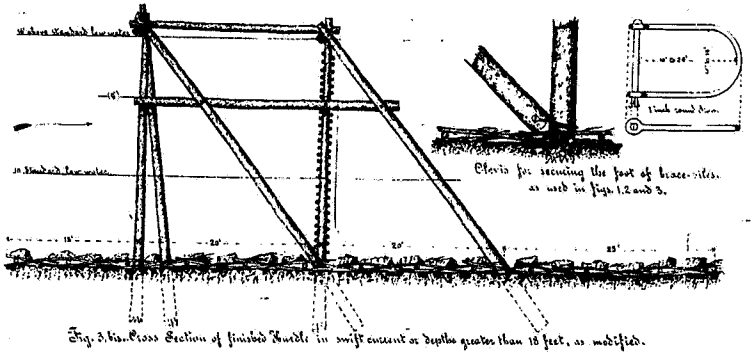


Fig. 3.bis. Cross Section of finished Bundle in swift current or depths greater than 18 feet, as modified.

Clevis for securing the foot of brace-piles, as used in figs. 1, 2 and 3.

Notes.

The bundles are built to the surface of the water unless the latter be lower than the plane 15' above standard low water, in which case they are built to the uniform height of 15' above standard low water. Their forms of construction vary somewhat with the depth of water at the 15' standard stage.

Fig. 1 shows the normal type.

For depths of 15' or more, the distance between the rows of piles is about equal to the depth of water. For example, in a depth of 18', the distance between rows is 18', as shown in drawing; for depths less than 15', the distance is constant and is kept at 15', except near the shore. In the latter case and in other cases of sudden and brief shoaling no change is made in the distance generally employed in that particular bundle.

For depths of 3' to 5' only two rows of piles are used, as shown in Fig. 2.

For depths of 3' or less, only one row of piles is used.

For depths of 6', or over a brig bar, no piles are used; but the foundation mattress 55' wide is laid upon the bare surface and well ballasted with stone, except where the bar is already protected by a natural growth of willows.

For depths of over 18', or for less depths where the current is very swift, cross stringers are used to brace together the tops of the piles in the three rows, as shown in Fig. 3.

Fig. 1 bis. shows a form with the brace driven, and used in bundle times Nos. 9 and 11 at Sulphur Springs, in place of the normal type, as shown in Fig. 1.

Fig. 3 bis. shows a type suitable for use in swift currents, with depth greater than 18 feet. Wherever practicable, one half of the cross stringers should be placed below the 10 ft. stage. This form was used in bundle times Nos. 5, 6 and 7 at Sulphur Springs, in place of the type shown in Fig. 3.

U.S. Engineers Office, St. Louis, Mo. Aug. 1887.

To accompany my annual report for the year ending June 30, 1887.

A. M. Miller

Major Corps of Engineers.

1888

boat was employed between the mouth of the Missouri River and Vicksburg, Miss., removing obstructions. The boat worked two months and a half, removing 798 snags, cutting down 348 trees, and traveling a distance of 1,792 miles. All the worst obstructions to navigation were removed, and commerce was greatly benefited thereby.

With the appropriation asked for the fiscal year ending June 30, 1890, it is proposed to continue the snagging operations and rebuild one of the wooden snag-boats for wrecking purposes.

No definite amount can be stated, as required, to complete this project. During every high-water season new snags and other obstructions are brought down and lodged in the channel; the banks are also continually caving in the river, and it is necessary to cut the timber where this is threatened to prevent the trees being caved into the river and forming new obstructions. For this reason an annual appropriation is required to properly carry on these operations.

July 1, 1887, amount available	$21,074.76
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	17,302.29
July 1, 1888, balance available	3,772.47
Amount appropriated by act of August 11, 1888	100,000.00
Amount available for fiscal year ending June 30, 1889	103,772.47

(See Appendix W 1.)

Removing obstructions Missouri River.—The necessity for the improvement of this stream was first recognised in 1832, as its navigation was rendered difficult and dangerous by numerous snags, etc., in the channel and leaning timber on the banks of the river.

The plan adopted for its improvement was the removal of these obstructions by snag-boats, and they have been used to great advantage.

The first appropriations having been made so as to cover the needs of several streams, the total amount expended on this river for the removal of obstructions can not be given. Since June 18, 1878, when the first specific appropriation was made, up to June 30, 1887, $456,306.46 was expended in that manner, greatly improving navigation during the low-water season.

During the fiscal year ending June 30, 1888, $3,445.29 was expended in watching and caring for the snag-boats. No appropriation having been made for continuing this improvement, no boat was sent to the river to remove obstructions, the balance on hand not being deemed sufficient for that purpose.

With the appropriation asked for fiscal year ending June 30, 1890, it is proposed to complete the outfit of new boat and continue the snagging operations, and it is expected that the worst obstructions can be removed and navigation rendered comparatively safe.

As new obstructions are continually brought down the river work is required every year, so that an annual appropriation is necessary.

July 1, 1887, amount available	$6,193.54
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,445.29
July 1, 1888, balance available	2,748.25

(See Appendix W 1.)

2. *Mississippi River between the Ohio and Illinois rivers.*—Work was carried on at Pulltight, Jim Smith's, and Sulphur Springs. Owing to lack of funds no other work could be undertaken. These works form parts

of one connected whole, carried on under a general scheme of making the improvement of the river continuous, beginning at Saint Louis and working down-stream, reducing the river to an approximate width of about 2,500 feet, and protecting the banks from erosion. The work between the Illinois River and Saint Louis consists in the maintenance of a channel 6 feet in depth.

Horsetail.—Cross-sections were taken here to ascertain the amount of fill. The results shown were as follows: Area over which fill has taken place, 915 acres. Area above 15 foot stage, on which willows are growing, 589 acres. Average fill over whole area, 11.86 feet. Greatest fill, 40.5 feet. Amount of material deposited, 17,500,000 cubic yards.

The effect of this remarkable fill has been to render this portion of the river navigable for the largest boats during the entire year and to remove one of the most troublesome bars, Horsetail, where trouble was always met with at low stages. The improvement of this locality may be considered complete, with the exception of the closing of Carroll's Island Chute, which still needs attention.

Twin Hollows, west bank.—The present project for the improvement of this locality was adopted in 1881. It consists in the building up of contraction works in order to confine the water. A channel of not less than 8 feet at low water has been obtained. No work was done here during the season. Cross-sections of work taken in the spring show the area over which fill has taken place to be 361 acres, 251 acres above 15-foot curve. Amount of material deposited, 11,389,259 cubic yards; average fill, 19.5 feet; greatest fill, 41.2 feet. Willows are growing over the area above the 15-foot curve.

Pulltight.—The project for the improvement of this locality was adopted in 1881, the object being to afford a channel of 8 feet at low water. The river at this point has shown a tendency to make a crossing above the point originally projected, and a careful study of this locality was made and works laid out in conformity with this tendency. Two hurdles were built from the east bank. The upper one, No. 4, was 3,000 feet long, and the lower, No. 5, 2,100 feet long. The rapid rise in the river and large run of drift damaged the first so that it is continuous for only about 1,700 feet from the east bank. No. 5 was completed its full length, and now holds. Work was discontinued on No. 4, as it was not economical to work at so high a stage. This hurdle will be completed as soon as the stage of the river permits, and it is confidently expected that this crossing will be greatly improved for low-water navigation. The middle bar has already been partially removed and a large deposit of silt obtained behind the hurdles. The amount expended during the year was $81,875.34, and the total amount expended to June 30, 1888, was $205,475.74.

Chesley Island.—No work was done at this locality. The object of the improvement here was to hold the head of the island and close the chute on its west side. Considerable difficulty has been met in closing this chute; every run out of the ice and drift during the spring rise has damaged the work. This year, however, the work has held and caused a large accumulation of drift in the head of the chute, and a fill in the chute, which will cause it to be dry at about the 15-foot stage, and it is expected that this will continue until the chute is entirely closed.

Jim Smith's.—The project for the improvement of this locality consists in construction of contraction works. The work done during the year was the revetment of the artificial bank opposite the head of Chesley Island; 1,775 feet were protected and held from erosion. The channel in this locality has been good during the year. To complete

work at this locality one hurdle is required to fill a vacancy left during construction for the accommodation of the steam-boat landing. The amount expended during the year was $18,824.98, and the total amount expended to June 30, 1888, was $327,039.44.

Sulphur Springs.—The project for improvement of this locality was adopted in 1881, and consists of contraction works. The hurdles constructed during the previous year were wattled, and a new hurdle, No. 16, built at the head of Foster's Island. This hurdle was extended from the shore of the island westward for a length of 1,620 feet, and stands completed. This completes the work at this locality except repairs. The ice damaged to some extent the hurdles constructed last season, to what extent can not be definitely stated until the water reaches a lower stage. The effect of the work has been very apparent. Large accumulations of material have been obtained behind the hurdles, in some places a fill of more than 20 feet, and the chute behind Foster's Island has been almost entirely closed for a 15-foot stage of river.

A reference to the plates, accompanying the report of the officer in charge, will give a graphic description of the progress and effect of the above works. The amount expended during the year was $25,246.98, and the total amount expended to June 30, 1888, was $177,964.24.

The original estimated cost of the work, as revised in 1883, was $16,997,100. The aggregate amount appropriated to June 30, 1888, is $3,739,600. The amount expended to June 30, 1887, is $3,521,508.50.

July 1, 1887, amount available		$216,173.02
Miscellaneous receipts		1,708.63
		217,881.65
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$122,195.19	
July 1, 1888, outstanding liabilities	28.09	
		122,223.28
July 1, 1888, balance available		95,658.37
Amount appropriated by act of August 11, 1888		300,000.00
Amount available for fiscal year ending June 30, 1889		395,658.37
Amount (estimated) required for completion of existing project		12,957,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		600,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix W 2.)

3. *Gasconade River, Missouri.*—This river was greatly obstructed by snags, logs, and leaning timber, which materially interfered with navigation. Work was commenced on this stream in 1880, and the project adopted for its improvement consisted in the removal of the snags and logs and the cutting of leaning timber and contraction works.

The amount expended to June 30, 1887, was $34,424.39, and at that time the navigation was much improved. During the fiscal year ending June 30, 1888, $3,013.64 was expended in constructing dams or training-walls at Round Island and Bock's Bar, in order to concentrate the water in the main channel of the river at those points. All troublesome obstructions were also removed.

The original estimate for the improvement of this stream was $50,000, of which $37,500 has already been appropriated, leaving an estimated amount of $12,500 to complete the project. This amount will probably be exceeded, as new obstructions are continually forming, and it will

W 2.

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE OHIO AND ILLINOIS RIVERS.

PROJECT.

The object of the improvement is to obtain a minimum depth at low-water of 6 feet from the mouth of the Illinois River to Saint Louis, a distance of 41 miles, and 8 feet from Saint Louis to the mouth of the Ohio River, a distance of 191 miles, the natural depth at low water being in many cases from 3½ to 4 feet. The initial point of the work for the lower portion is Saint Louis, the program being to make the work continuous, working down-stream from that city. Work at detached points has also been carried on under allotments specially made by law for the improvement of landings and the protection of local interests.

The plan of general improvement contemplates a reduction of the river to an approximate width of 2,500 feet below Saint Louis (the natural width being in many cases from 1 to 1½ miles) and the protection of the alluvial banks from erosion. The methods employed are to build up new banks with the solid matter caught from the river itself by means of hurdles, and revetment of the banks, both new and old, when necessary.

ORGANIZATION.

The organization of the engineering staff during the season was as follows:

A supervising engineer was assigned to the general supervision of all the works and of the supply depot; his office was in Saint Louis, and his duties were to advise and direct the resident engineers, and to have special charge of the supply of brush, stone, and piles, and of the tow-boat and barges engaged in that work.

The resident engineer was provided with quarters and an office at the work. His duties were to have immediate direction of the work of construction; to make such surveys and observations as might be required to keep the progress map, upon which all work was to be located as fast as constructed; to keep the journal and other records of the work, to prepare pay-rolls, to render quarterly property returns, semi-annual and annual reports to the officer in charge, forwarding them through the superintending engineer. The superintending engineer was Mr. D. M. Currie. Resident engineers: At Pulltight, Mr. John O. Holman, for the revetment work done in the fall of 1887, and Mr. W. S. Mitchell, for the hurdle work done in the spring of 1888. The revetment work at Jim Smith's and the hurdle work at Sulphur Springs was under Mr. John O. Holman. The procurement of brush was under Mr. C. D. Lamb.

WORK ACCOMPLISHED.

Owing to the small amount of funds available the only work laid out for the year was the revetment of the artificial bank at the head of Pulltight and Jim Smith's, the construction of two hurdles at Pulltight Crossing, the partial wattling of the hurdles at Sulphur Springs, and the construction of Hurdles No. 16 of the Sulphur Springs system, at the head of Foster's Island.

Plate I is a general map of the river between the Saint Louis Bridge and Foster's Island, showing the location of these works.

HORSETAIL.

No work of construction was done at the locality; the hurdles closing the chute of Carroll's Island was damaged somewhat by the ice, and the high water has as yet prevented its repairs. A series of cross-sections was taken at Horsetail, showing the amount of fill accomplished here since the inauguration of the present contraction works. The work here may be considered as complete and has accomplished the desired result, that is the obtaining a good channel of at least 8 feet at low water. This locality was, before work was commenced, the most troublesome below Saint Louis; it is now a very rare occurrence for a steam-boat to cast the lead, when it was a common occurrence for several boats to be aground together at low water. The made ground here covers an area of 915 acres, 589 of which appear above a 15-foot stage of the Saint Louis gauge, whose zero is the low water of 1863, and this latter portion is covered with a thick growth of willows. The average fill has been 11.86 feet, the greatest fill was 40.5 feet. The amount of material deposited was about 17,500,000 cubic yards, at a cost of about 2½ cents per cubic yard. This shows what may be accomplished by this system when funds are available for continuous work. When a stretch of works can only be done partially and then left for want of appropriations the repairs are a very considerable item of expense.

Plate II shows the cross-sections and deposit at Horsetail.

TWIN HOLLOWS.

No work was done at this locality during the year. A series of cross-sections were taken, as at Horsetail, and the results shown on Plate III.

The area covered by material deposited is 301 acres; the area which appears above the 15-foot stage is 251 acres; the amount of material deposited is 11,389,259 cubic yards; average height of fill, 19½ feet, and greatest fill, 41.2 feet. The portion above the 15-foot stage is covered with willows. The channel at this locality is in good condition.

PULLTIGHT.

The original project for this locality was to send the channel down the east side of the river, by Beard's Island, making a crossing to the west side at Fine's Bluff, just above the mouth of the Meramec River. A study of this locality showed that the natural tendency of the river was to make the crossing above this point at White House, and at low stages there was a tendency to shoal; it was thought best to close the east side of the river by constructing hurdles and throw as much water as possible into the White House Crossing and improve and preserve this. With this view two hurdles were laid out and constructed, the first in prolongation of No. 4 of the Pulltight system and the second 2,800 feet below. The work was begun April 15 and continued until June 30. Hurdle No. 4 was built to a length of 3,025 feet, but owing to the rising river and a large run of drift it was damaged at several points and breaks made in it; there are 1,750 feet still intact. The repairs will be made as soon as the river falls sufficiently to work economically. Hurdle No. 5 was built for a length of 2,100 feet, and is now intact to a point 2,500 feet from the west bank of the river; several breaks caused by drift were repaired during its construction. These hurdles have caused a large deposit and have moved the middle bar at this point so that the low-water channel will be much improved. In the fall the

head of the artificial bank at Pulltight was revetted for a distance of 1,825 feet, in order to prevent a threatened caving at this point. (See Plate IV.)

CHESLEY ISLAND.

No work was done at this locality. The object of the work here was to close the chute between the island and shore. Considerable difficulty had been encountered here from ice and drift, but the hurdle has stood this season's ice and flood, and a large fill has taken place; the chute will be almost dry at the 15-foot stage. (See Plate IV.)

JIM SMITH'S.

The work at this point consisted in the revetment of the artificial bank opposite the head of Chesley Island; a length of 1,775 feet was protected, and the caving has been prevented. The works at this point are in good condition, and have built up the new bank of the river as intended. A gap exists in the line of hurdle between No. 7½ and No. 1 of the Sulphur Springs system. This hurdle (No. 8) was omitted in order to accommodate the commerce here and allow a steam boat landing. It is proposed to place this hurdle the coming season. (See Plate IV.)

SULPHUR SPRINGS.

Work at this locality consisted in the wattling of hurdles and the construction of Hurdle No. 16, at the head of Foster's Island. This hurdle was built for a length of 1,620 feet. A somewhat different method was employed here—a departure from former methods (see Report Chief of Engineers, 1887, Plate V, facing page 1564.) The drift-row was driven in clumps in order to withstand she heavy run of drift which occurred during the spring rise. This hurdle completes the Sulphur Springs system. During the outrun of ice this season considerable damage was done the Sulphur Springs hurdles; the amount can not be fully ascertained until a fall in the river occurs. The work here has caused a very heavy fill as shown on (Plate IV) and has closed the Foster Island Chute at all but high stages; in some places the fill has been over 20 feet and willows will grow on these bars this season or next. Plate IV shows the bars as they will appear at a 15-foot stage.

REMOVAL OF SNAGS.

Complaints having been made by steam-boat owners and pilots of the danger to navigation from snags, and no funds being available from rhe appropriation for removal of obstructions in the Mississippi River, application was made October 27, 1887, for authority to expend not to exceed $6,000 for the removal of snags. This authority was granted by the honorable the Secretary of War, November 4, 1887.

The United States snag-boat *H. G. Wright* was put in commission and worked from November 14 to December 6, removing 175 snags and 162 leaning trees, thus greatly relieving the river and removing these dangerous obstacles. Four thousand two hundred and eighty dollars and forty-five cents was expended in this service.

MATERIAL.

Brush.—The brush used in construction work was procured by hired labor, a royalty of 10 cents per cord being paid to the owners of land from which the brush was taken.

Stone was procured by contract in the fall from Glenwood Lime and Quarry Association at 47½ cents per cubic yard, and for the work in the spring from the Grafton Quarry Company at 40 cents per cubic yard.

Piles were obtained by contract with Mr. John Cleary at from 8 to 10 cents per linear foot according to length.

Rope, iron, wire, bolts, spikes, etc., were obtained by contract from various parties as per abstract of bids appended. Subsistence was purchased in open market on bids from various dealers.

SUPPLY DEPOT.

The supply depot was under the immediate charge of Mr. C. L. Stevenson until April 1, when he was obliged by sickness to go to hospital, since which date the supply and subsistence departments have been under the charge of Mr. S. S. Van Norman. All supplies, except brush, stone, and piles, as obtained were delivered at the depot, whence they were distributed on requisition to the various works. In addition to this function of the depot it was a general repair shop, where all repairs to plant, not requiring dockage, was made. During the season 10 pile-drivers were repaired; 23 barges caulked and repaired; 2 quarter boats caulked; and matress barges, flats, yawls, and skiffs repaired and put in order. Some minor repairs were made to the tow-boat *General Gillmore* and piles driven to replace the landing at depot.

The present valuation of the property remaining to be distributed on installation account is given in the following table:

Class of property.	Balance June 30, 1887.	Debits.	Credits.	Balance June 30, 1888.
Barges, model and flat	$58,818.37	$7,635.06	$16,681.24	$49,772.19
Boat machine-shop	1,484.26	128.88	.....	1,613.14
Boats, quarter	1,777.15	625.08	997.39	1,450.44
Drivers, pile	30,467.00	1,843.12	4,883.50	33,426.62
Flats	4,869.13	1,479.18	2,966.97	3,381.34
Machinery, steamer *Humphreys*	6,000.00	.75	.75	6,000.00
Shanties, portable	14,305.00	707.67	3,425.62	11,587.05
Skiffs	722.62	614.02	688 62	648.02
Steamer *General Gillmore*	16,046.05	14,077.68	15,837.83	14,286.80
Tents	211.05	3.25	24.45	189.75
Ways for mattress	1,084.70	233.61	.....	1,318.31
Yawls	865.84	111.05	376.21	601.28
Supply depot	2,751.00	1,553.63	699.30	3,605.33
Tools and appliances	1,640.83	1,016.75	1,283.53	1,074.05
Boarding outfit	12,377.40	523.00	1,844.99	11,055.41
Office furniture	500.75	.....	90.28	410.47
Surveying instruments	616.31	95.00	137.10	574.21
Photographic apparatus	222.75	.....	22.27	200.48
Total	160,708.01	31,248.93	49,966.05	142,050.89

GAUGES.

The gauges at Grafton and Gray's Point were read daily during the season. The readings are appended, marked A.

CONDITION OF THE RIVER.

The channel depths, as furnished by the Saint Louis and New Orleans Pilot Association during the low-water season, are appended, marked B.

The river was closed to navigation by ice from December 21 to 31 and from January 21 to 31. The low-water season continued from the middle of July till the close of navigation by ice.

The least depth of water reported was $4\frac{5}{6}$ feet at Fort Chartres and Kinney Point, while the least depth reported by the same boat, the steamer *Arkansas City*, on the same date, October 28, in the improved portion of the river, was $6\frac{1}{2}$ feet at Sulphur Springs. The water was lower than usual this year.

SURVEYS.

A survey of the river was made in the fall of 1887, and extended from the foot of Beard's Island to Cliffdale Hollow, a distance of $17\frac{1}{2}$ miles. The object of this survey was to locate the bars and changes in the portion of the river under improvement, and to obtain data upon which to locate work for an extension of the system of improvement.

The party was in the field from September 19 till November 22, and the work was platted to a scale of $\frac{1}{5000}$. (See report of Mr. W. S. Mitchell.)

Cross-sections were taken in the spring of 1888 at Horsetail and Twin Hollows, to show the fill at these localities. The results appear in Plates II and III.

COMMERCIAL STATISTICS.

The commercial statistics below were obtained partially from the Merchant's Exchange of Saint Louis and partially from other sources. Great difficulty was met with in placing a valuation on miscellaneous or general merchandise. The tonnage transferred across the river by ferries is estimated at $60 per ton. In the table below the general merchandise has been estimated at $30 per ton; this is considered a fair estimate.

Receipts and shipments at Saint Louis during the year ending December 31, 1887.

River.	Articles.	Receipts.		Shipments.	
		Tons.	Estimated value.	Tons.	Estimated value.
Mississippi below Saint Louis.	Merchandise and grain*	268,735	$8,853,114.68	538,065	$21,356,933.18
Mississippi above Saint Louis.	....do*	132,400	3,605,257.03	36,170	1,085,100.00
Missouri	....do*	27,700	982,460.05	14,580	437,400.00
Illinois	....do*	78,560	895,652.86	7,125	213,750.00
Ohio	Merchandise and iron ore.*	121,670	1,924,252.83	19,035	605,000.00
Cumberland and Tennessee.	Merchandise and grain*	23,815		18,715	
Red and Ouachita	....do*			3,370	101,100.00
Mississippi above Saint Louis.	Lumber, shingles, etc†	213,165	2,431,215.93		
Mississippi below Saint Louis.	....do*		267,115.08		
Mississippi below Saint Louis and Missouri.	....do*		52,683.26		
Mississippi between Saint Louis and Cairo.	Flour, grain and bran†			34,457	1,030,000.00
Total		866,045	19,011,751.72	671,517	24,889,283.18

*Tonnage obtained from Saint Louis Merchants' Exchange report. Values estimated from average prices given by commercial papers and dealers.

†Tonnage from steam-boat manifests. Values from average prices.

Recapitulation.—1,537,562 tons, valued at $43,901,034.90.

REPORTS OF ASSISTANTS.

There are submitted herewith the reports of the superintending engineer, Mr. D. M. Currie, and the reports of assistants, by reference to which all details and particulars can be obtained.

ESTIMATE.

The amount that can be profitably expended during the year ending June 30, 1890, is $1,000,000. It is proposed to expend this sum in carrying out the programme heretofore adopted. That is, to carry on the work of improvement continuously from Saint Louis down-stream, reclaiming land by building up new banks, thus reducing the river to an approximate width of 2,500 feet; alluvial banks to be protected from erosion. It is proposed by this means to obtain a channel of at least 8 feet at low-water. The depth now is liable to become as small as 4 feet, or even less in some places, and less than 8 feet at every locality where the width is more than 2,500 feet. In my last report I asked for the same amount, but the river and harbor bill, as just passed both houses of Congress, appropriates only $300,000. With this sum it is not possible to make the proper progress necessary for so important a work, and the steam-boat interests are suffering from such small appropriattions.

This general statement of the proposed application of the appropriation is as specific as the nature of the case admits. The changeable character of the river renders it impracticable to give in advance the exact locality where works will be required.

The original estimated cost of this work, as revised in 1883, was	$16,997,100.00
The aggregate amount appropriated to June 30, 1888, is	3,739,600.00
The amount expended to June 30, 1887, is	3,521,508.50

Abstract of appropriations made for present plan of improvement.

By act of—	
March 3, 1873	$200,000
June 23, 1874	200,000
March 3, 1875	200,000
August 14, 1876	229,600
June 18, 1878	260,000
March 3, 1879	215,000
June 14, 1880	320,000
March 3, 1881	620,000
August 2, 1882	600,000
July 5, 1884	520,000
August 5, 1886	375,000

Money statement.

July 1, 1887, amount available		$216,173.02
Miscellaneous receipts		1,708.63
		217,881.65
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$122,195.19	
July 1, 1888, outstanding liabilities	28.09	
		122,223.28
July 1, 1888, balance available		95,658.37
Amount appropriated by act of August 11, 1888		300,000.00
Amount available for fiscal year ending June 30, 1889		395,658.37

Amount (estimated) required for completion of existing project	12,957,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

MAP OF
MISSISSIPPI RIVER
FROM
SAINT LOUIS BRIDGE TO FOSTER ISLAND.
Showing location of works of improvement.

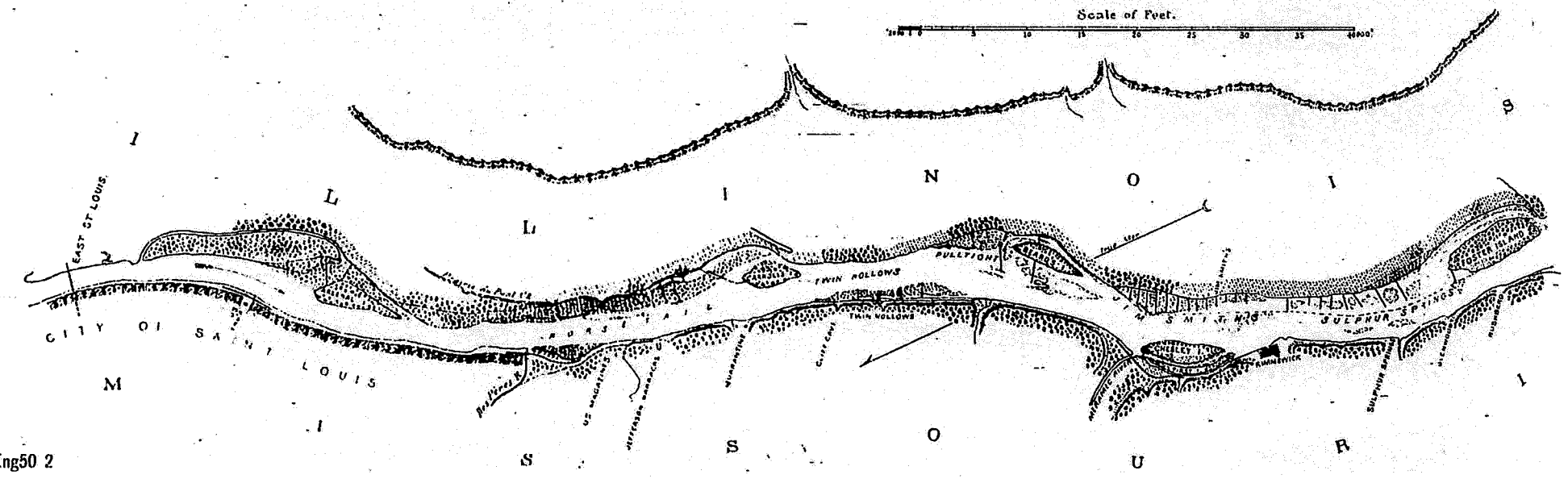


PLATE II.

MISSISSIPPI RIVER
at
HORSETAIL, EAST SIDE.

CROSS SECTIONS showing fill secured from March 9th 1880 to Mar. 5th 1888, by the HURDLE system of improvement in use since 1880.

Bars are shown as they appear, Mar. 5, 1888, at a stage 15 ft. above low water of 1863, or 11 ft. above standard low water.

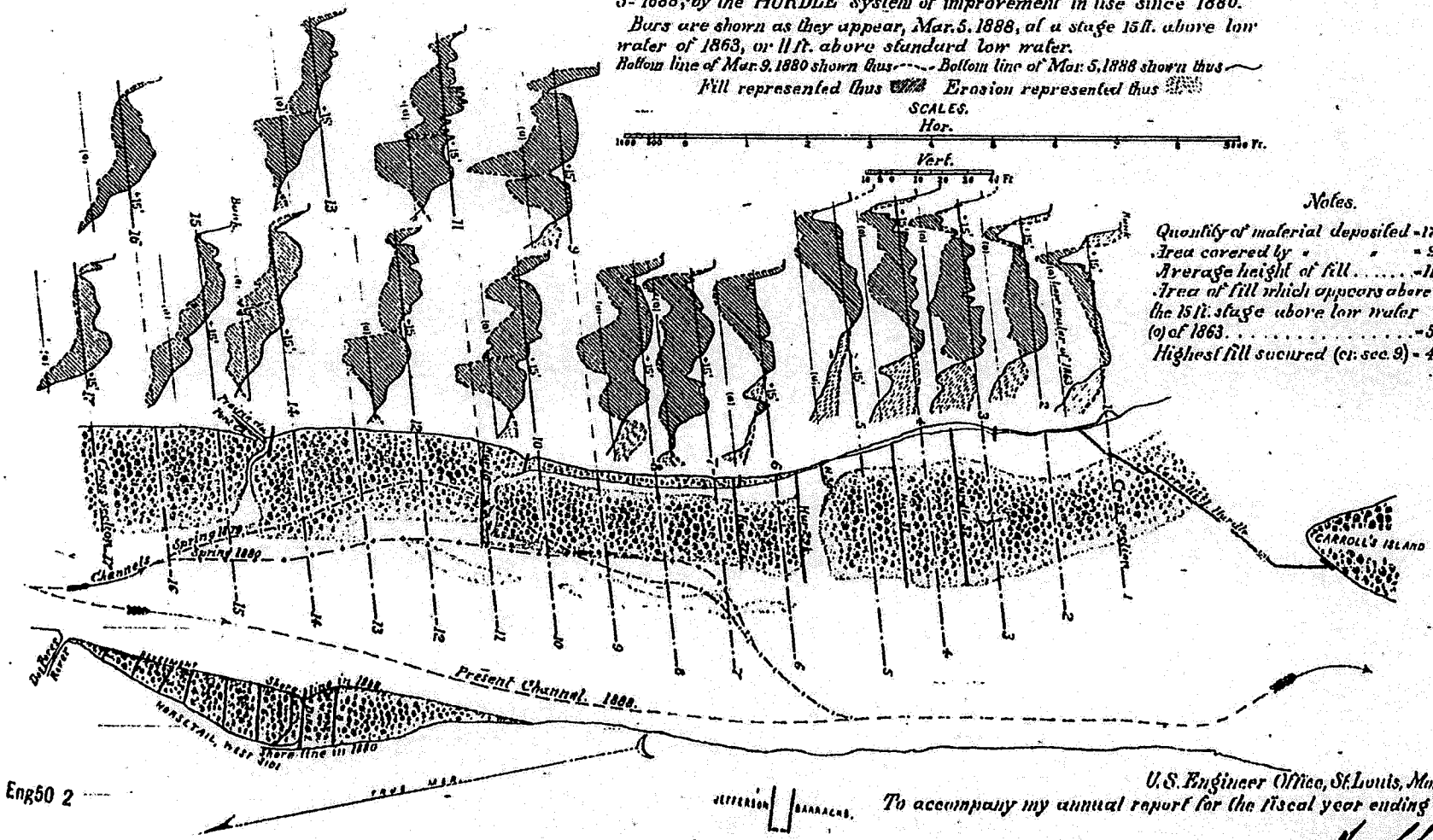
Bottom line of Mar. 9, 1880 shown thus ------ Bottom line of Mar. 5, 1888 shown thus ~~~

Fill represented thus ▨ Erosion represented thus ▩

SCALES.

Hor. 1000 500 0 1 2 3 4 5 6 7 8 9 10 Stile Ft.

Vert. 10 0 10 20 30 40 Ft



Notes.

Quantity of material deposited = 17511925 cu yds.
Area covered by " " = 915 acres.
Average height of fill ..... = 11.86 feet.
Area of fill which appears above the 15 ft. stage above low water (0) of 1863 ..... = 589 acres.
Highest fill secured (cr. sec. 9) = 40.5 feet.

U.S. Engineer Office, St. Louis, Mo. July 9, 1888.

To accompany my annual report for the fiscal year ending June 30, 1888.

H. M. Miller
Major Corps of Engineers.

Eng50 2

MISSISSIPPI RIVER

at

TWIN HOLLOWS, WEST SIDE.

PLATE III.

CROSS SECTIONS showing fill secured from Oct. 22, 1880 to Mar. 15, 1888, by the HURDLE system of improvement, in use since 1880.

Bars are shown as they appear Mar. 15, 1888 at a stage 15 ft. above low water of 1863, or 11 ft. above standard low water.

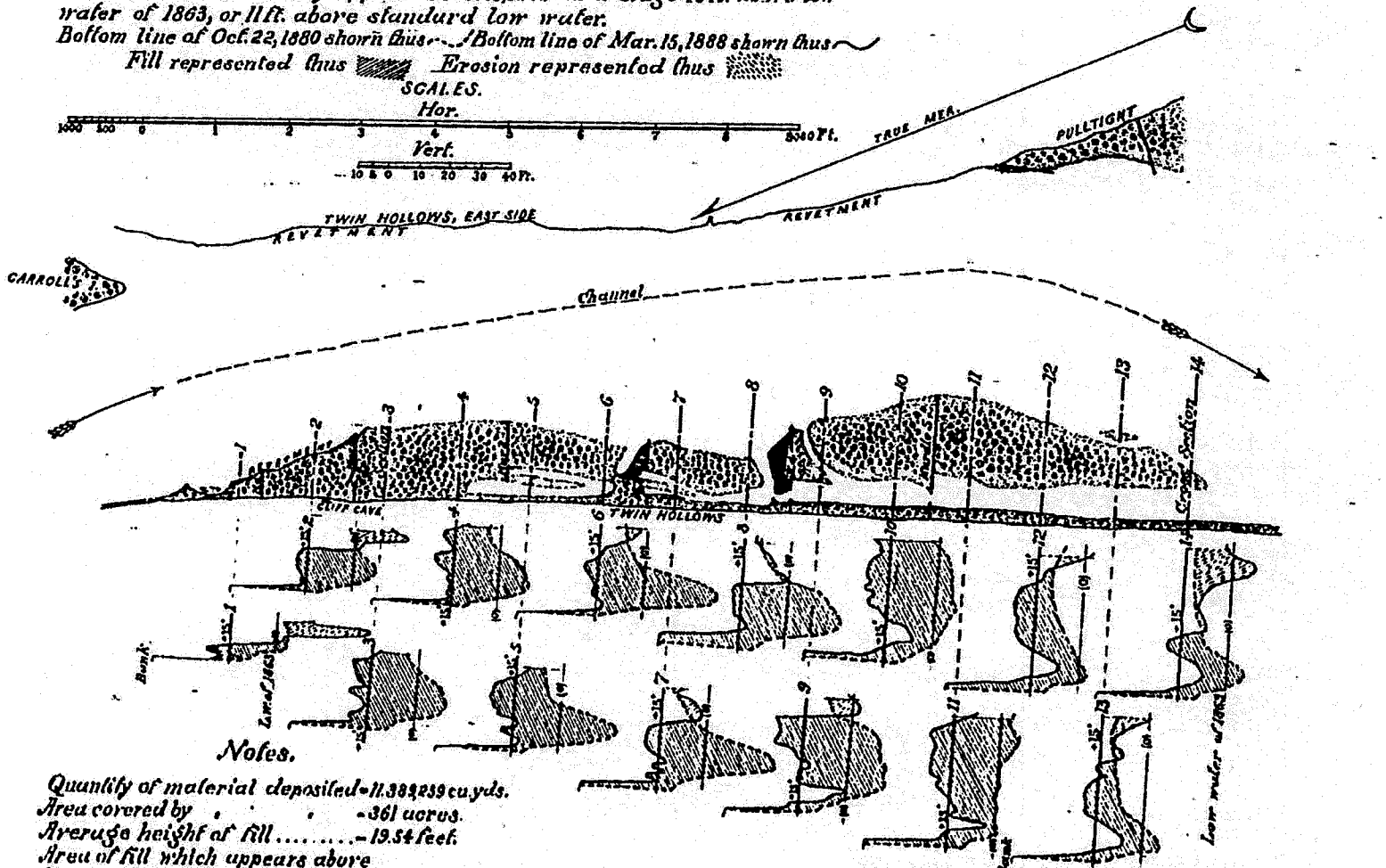
Bottom line of Oct. 22, 1880 shown thus ---- Bottom line of Mar. 15, 1888 shown thus ~~~

Fill represented thus ▨ Erosion represented thus ▩

SCALES.

Hor. 1000 500 0 1 2 3 4 5 6 7 8 5280 Ft.

Vert. 10 5 0 10 20 30 40 Ft.



Notes.

Quantity of material deposited = 11,388,239 cu. yds.
Area covered by . . . = 361 acres.
Average height of fill . . . . . = 19.54 feet.
Area of fill which appears above the 15 ft. stage, above low water (0) of 1863. . . . . = 252 acres.
Highest fill secured (cr. sec. 6) = 41.2 feet.

U.S. Engineer Office, St. Louis, Mo. July 9, 1888.

To accompany my annual report for the fiscal year ending June 30, 1888.

A. M. Miller

Major Corps of Engineers.

Eng50 2

PLATE IV.

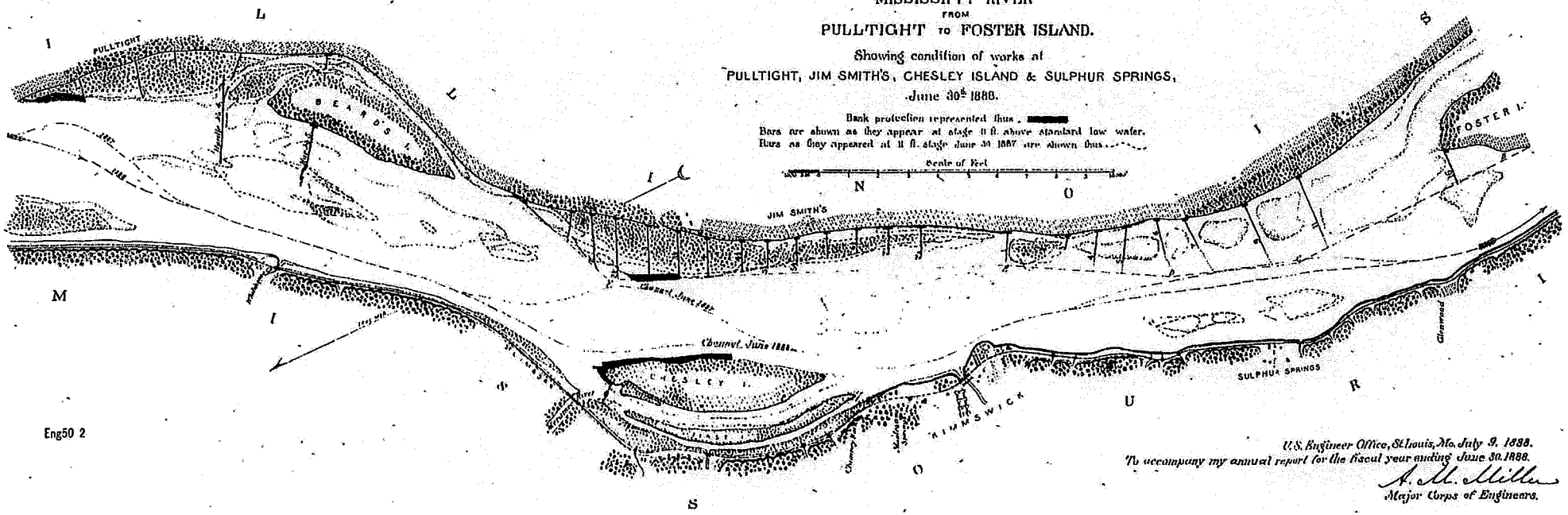
MAP OF MISSISSIPPI RIVER FROM PULLTIGHT TO FOSTER ISLAND.

Showing condition of works at PULLTIGHT, JIM SMITH'S, CHESLEY ISLAND & SULPHUR SPRINGS, June 30th 1888.

Bank protection represented thus ▬▬

Bars are shown as they appear at stage 11 ft. above standard low water.
Bars as they appeared at 11 ft. stage June 30 1887 are shown thus - - - -

Scale of Feet



Eng50 2

U.S. Engineer Office, St Louis, Mo. July 9. 1888.
To accompany my annual report for the fiscal year ending June 30. 1888.

A. M. Miller
Major Corps of Engineers.

River Commission, on September 28, 1888, by direction of the Secretary of War.

July 1, 1888, amount available	$2,748.25
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	765.45
July 1, 1889, balance available	1,982.80

(See Appendix Y 1.)

2. *Mississippi River, between the Ohio and Illinois rivers.*—The original condition of the navigable channel of this portion of the Mississippi River, before the work of improvement was begun, was such that the natural depth at low water was in many cases from 3½ to 4 feet and the water was scattered by islands which formed sloughs behind them, thus wasting the water available for low-water navigation.

The project for improvement adopted consisted in closing these sloughs and by contraction works to concentrate the water between banks 2,500 feet apart, the object being to thus obtain a depth of 8 feet in the channel between St. Louis and Cairo and 6 feet between Grafton and St. Louis at standard low water, or at a stage corresponding to a gauge reading of 4 feet on the St. Louis gauge.

The amount expended up to the close of the fiscal year ending June 30, 1888, was $3,648,150.11. The condition of the improvement at this latter date was such that a good channel of not less than 8 feet was maintained from St. Louis to Bushberg, a distance of 27 miles, as far as work had been carried up to that time.

The amount expended during the fiscal year ending June 30, 1889, was $173,827.34. The work accomplished by this expenditure having been almost entirely done since the beginning of March, 1889, it has not been sufficiently long in place to state as yet what results it has produced in increasing the depth and otherwise benefiting navigation; but reasoning from analogy and from results produced heretofore by the same system and methods, it may be confidently stated that the results will be very beneficial to navigation in increasing the channel depth.

During the fiscal year ending June 30, 1889, work was done at the following localities:

Horsetail.—The work at this locality consisted in the repair of the hurdle, closing the chute to the east of Carroll's Island, which had been damaged by ice and partially burned down by hunters or fishermen during the winter; 450 feet of hurdle was built and the bank revetment at head of island repaired. This work may be considered as completed and has resulted in an average fill of about 12 feet over an area of 1,000 acres, has reduced the river to a width of 2,500 feet, and rendered it navigable for the largest boats, and removed one of the worst bars in the river ("Horsetail"), where trouble was always met with at low water. The amount expended during the fiscal year ending June 30, 1889, was $4,093.58.

Twin Hollows.—The work at this locality consisted in the revetment of the artificial bank near the head of the works, which showed a tendency to erosion. The work was done on the west bank, and 115,450 square feet of protection, consisting of brush matress and stone, was placed in position, protecting a length of 1,570 feet of bank. Amount expended during fiscal year ending June 30, 1889, was $7,817.65.

Pulltight.—The project for the improvement of this locality was adopted in 1881. The river at this point has shown a decided tendency to make a "crossing" above the point originally projected, and a careful study of the locality was made and works laid out in conformity

with this tendency. Four hurdles were projected to be built from the east bank, in order to throw the river across the middle bar here existing.

Work was begun on the two upper hurdles in March, the two lower having been built the previous year. These hurdles were nearly completed when they were badly broken about the last of May by drift brought down by a sudden rise, and work has since then consisted in their repair. These repairs were nearly completed at the end of the fiscal year.

The effect of these hurdles can not be determined till low water, but from present appearances they will accomplish the desired result of cutting away the middle bar; 2,775 linear feet of hurdles were constructed here and extensive repairs made.

The amount expended for the fiscal year ending June 30, 1889, was $104,495.96.

Jim Smith's.—The project for the improvement of this locality consists in the construction of contraction works. On account of the existence of a very persistent middle bar it was determined to further extend the hurdles in order to close the chute to the east of the bar, and concentrate the water in such a manner as to remove it; two hurdles were extended an aggregate distance of about 1,500 feet, when the plant was removed to Pulltight to assist in the repairs at that point. Amount expended during fiscal year ending June 30, 1889, was $14,079.66, which also includes amount expended at Sulphur Springs.

Sulphur Springs.—The work at this locality is contraction work, the hurdles extending from the east bank. The project for this locality contemplated the extension and repair of the hurdles. The plant being otherwise occupied, the only work accomplished was the wattling of hurdle No. 16 at the head of Foster's Island. The work at this locality has very much improved the lower crossing.

Lucas'.—The project for work at this locality was adopted in 1888. It consists in contracting the river width to 2,500 feet, and preventing the waste of water now flowing through the chute behind Calico Island. This is a new work; four hurdles were built here whose aggregate length is 7,170 linear feet; they have been constructed since March, 1889, and the effect of the work can not be absolutely stated until low water. It is the continuation of the general project which has succeeded above. Amount expended for fiscal year ending June 30, 1889, was $67,427.60.

A reference to the plates accompanying the report of the officer in charge will give a graphic representation of the progress and effect of these works. The amount expended during the year was $173,827.34, and the total amount expended to June 30, 1889, was $3,822,005.54.

The original estimated cost of the work, as revised in 1883, was $16,997,100. The aggregate amount appropriated to June 30, 1889, is $4,039,600. The amount expended to June 30, 1888, is $3,648,150.11.

July 1, 1888, amount available		$95,658.37
Amount appropriated by act of August 11, 1888		300,000.00
		395,658.37
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$173,827.34	
July 1, 1889, outstanding liabilities	17,980.74	
July 1, 1889, amount covered by existing contracts	32,507.95	
		224,316.03
July 1, 1889, balance available		171,342.34

Amount (estimated) required for completion of existing project	$12,957,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1891	600,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Y 2.)

3. *Gasconade River, Missouri.*—This river was greatly obstructed by snags, logs, and leaning timber, which materially interfered with navigation. Work was commenced on this stream in 1880, and the project adopted for its improvement consisted in the removal of the snags and logs and the cutting of leaning timber and the construction of contraction works at shoal crossings.

The amount expended to June 30, 1888, was $37,438.03, and at that time the navigation was much improved. During the fiscal year ending June 30, 1889, $2,498.06 was expended in removing obstructions from the bed of the river and cutting down leaning timber from the banks, thereby rendering the navigation of the river much safer.

The original estimate for the improvement of this stream was $50,000, of which $42,500 has already been appropriated, leaving an estimated amount of $7,500 to complete the project. This amount will probably be exceeded, as new obstructions are continually forming, and it will require a small amount each year to keep the channel open after the principal work has been done.

July 1, 1888, amount available	$61.97
Amount appropriated by act of August 11, 1888	5,000.00
	5,061.97
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	2,498.06
July 1, 1889, balance available	2,563.91

Amount that can be profitably expended in fiscal year ending June 30, 1891	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Y 3.)

4. *Osage River, Missouri.*—The navigation of this stream was very much interfered with by obstructions in the channel and shoal crossings. The original project, adopted in 1871, was to obtain a low-water navigation of 2 feet by means of dams and training-walls, but this was abandoned and a new project, consisting in the removal of snags and logs, cutting of leaning timber and constructing dams and training-walls at shoal crossings, was adopted.

The amount expended to June 30, 1888, was $195,844.52, at which time the navigation was in a fair condition, the worst obstructions having been removed. During the fiscal year ending June 30, 1889, $4,248.52 was expended in extension and repair of dam and training wall at Hoskin's Shoal, in repairing dam at Moore's Flat, and in removing obstructions from 60 miles of the river. This improved the navigation at low water by increasing the depths over the shoals and making the navigation of the river much safer than formerly.

No estimate was made for the improvement of this stream under the second project; an annual appropriation is, however, required to keep this stream in navigable condition by the removal of new obstructions that are brought down during the floods.

MISSOURI RIVER.

No work was done under the supervision of this office during the year.

By the terms of the river and harbor act of August 11, 1888, this work was placed under the Missouri River Commission, and the snag-boat *C. R. Suter* and other property belonging to the work were transferred to Lieut. Col. C. R. Suter, Corps of Engineers, president Missouri River Commission, on September 28, 1888, by direction of the Secretary of War.

Money statement.

July 1, 1888, amount available	$2,748.25
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	765.45
July 1, 1889, balance available	1,982.80

Y 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN THE OHIO AND ILLINOIS RIVERS.

PROJECT.

The object of the improvement is to obtain a minimum depth at low water of 6 feet from the mouth of the Illinois River to St. Louis, a distance of 41 miles, and 8 feet from St. Louis to the mouth of the Ohio River, a distance of 191 miles, the natural depth at low water being in many cases from 3½ to 4 feet. The initial point of the work for the lower portion is St. Louis, the programme being to make the work continuous, working down-stream from that city. Work at detached points has also been carried on under allotments specially made by law for the improvement of landings and the protection of local interests.

The plan of general improvement contemplates a reduction of the river to an approximate width of 2,500 feet below St. Louis (the natural width being in many cases from 1 to 1½ miles) and the protection of alluvial banks from erosion. The methods employed are to build up new banks with the solid matter caught from the river itself by means of hurdles, and revetment of the banks, both new and old, when necessary.

ORGANIZATION.

The organization of the engineering staff during the season was as follows:

A supervising engineer was assigned to the general supervision of all the works and of the supply depot; his office was in St. Louis, and his duties were to advise and direct the resident engineers, and to have special charge of the supply of brush, stone, and piles, and of the tow-boat and barges engaged on the work.

The resident engineer was provided with quarters and an office at the work. His duties were to have immediate direction of the work of construction; to make such surveys and observations as might be required to keep the progress map, upon which all work was to be located as

fast as constructed; to keep the journal and other records of the work, to prepare pay-rolls, to render quarterly property returns, semi-annual and annual reports to the officer in charge, forwarding them through the superintending engineer.

The superintending engineer was Mr. D. M. Currie. Resident engineers: At Pulltight, Mr. William S. Mitchell; at Lucas, Mr. John O. Holman; and for revetment work at Twin Hollows, contraction work at Sulphur Springs and Jim Smith's, also procurement of brush, Mr. C. D. Lamb.

WORK ACCOMPLISHED.

The work laid out for the fiscal year under the approved project was the repair of hurdle No. 4 at Pulltight, the extension of hurdles Nos. 1 and 2 at the same locality, the extension and repair of hurdles at Sulphur Springs and Jim Smith's, the commencement of the new system at Lucass's, and the removal of a portion of the dam at Piasa Island. Owing to the unfavorable condition of the river no work was done at this last-named locality.

Plate I is a general map of the river between the St. Louis Bridge and Calico Island, showing the location of these works.

HORSETAIL.

The work in this reach consisted in the repair of the hurdle designed to close the chute to the east of this island. During the winter the hurdle had been damaged by ice and partially burned by hunters or fishermen. These damages were repaired and the revetment at the head of Carroll's Island strengthened; 450 linear feet of hurdle was built and $4,093.58 expended. These repairs were completed September 15, 1888, and have since remained intact and resulted in a large fill, which will probably, after next high water, close this chute at the 20-foot stage on the St. Louis gauge. The improvement of this locality may be considered as complete unless some unforeseen accident occurs to the work at Carroll's Island. The river has been contracted to a width of 2,500 feet and an average fill of about 12 feet secured over an area of 1,000 acres on the east side, where steam-boats were frequently aground at low water and the channel exceedingly tortuous; there is now an easy, well-defined channel, and pilots do not even cast the lead. For a distance of 7,000 feet from the river Des Peres down-stream the contraction works have been carried out from both banks, the new bank having been revetted on the west side. This shows what may be accomplished by this system when funds are available for continuous work. When a stretch of works can only be partially completed and left for want of funds the repairs are a very considerable item of expense. Plate II shows the hurdle at the head of Carroll's Island.

TWIN HOLLOWS.

The work at this locality consisted in the continuation of the revetment of the new bank, near its head, for a distance of 1,750 feet; 115,450 square feet of protection, consisting of brush mattress and stone, were placed in position at a cost of $7,817.65. The channel in this locality is in very good condition, and navigation has been greatly benefited by the works, which consist in contraction on the west side and protection on the east bank.

The area covered by material deposited is 361 acres, of which 251 acres appear above the 15-foot stage on the St. Louis gauge, covered with a vigorous growth of willows. There are still some sloughs in this

area at high water, but these are gradually becoming closed by silt. (See plate II.)

PULLTIGHT.

The original project for this locality was to send the channel down the east side of the river, by Beard's Island, making a crossing to the west side at Fine's Bluff, just above the mouth of the Maramec River. A study of this locality showed that the natural tendency of the river was to make the crossing above this point at White House, and at low stages there was a tendency to shoal; it was thought best to close the east side of the river by constructing hurdles and throw as much water as possible into the White House crossing and improve and preserve this. With this view two hurdles were laid out and constructed, the first in prolongation of No. 4 of the Pulltight system and the second 2,800 feet below. These two hurdles were constructed during the fiscal year ending June 30, 1888. It was found, however, that this did not cause the crossing to take place high enough up-stream to cross the middle bar, but caused the channel to follow at low water along the upper hurdle, making a very abrupt turn at the west bank of the river at White House, and by its scour weakening and damaging the hurdle. Two other hurdles in continuation of Nos. 1 and 2 of the Pulltight system were projected and built during the fiscal year ending June 30, 1889. No. 2 was placed 2,000 feet above No. 4, and No. 1, 1,200 feet above No. 2. Hurdle No. 1 was completed May 9 for a length of 1,500 feet, and on May 14 hurdle No. 2 to a distance of 1,275 feet from the east bank.

Considerable difficulty was met with in the construction of these hurdles on account of the deep water and swift current in the channel which they were designed to close. A rapid rise in the river occurring in the latter part of May caused a very heavy run of drift, which hurdle No. 1 could not withstand; it broke about middle point, making a gap of about 150 feet in width, and thus allowing the accumulation of drift and débris to rush against hurdle No. 2; this latter, as well as No. 4 of last year's work, was broken; immediate steps were taken to repair this damage by the concentration of plant from Jim Smith's, and afterwards Lucas's, and on June 30 the repairs to hurdle No. 2 were complete and No. 1 repaired with the exception of a short gap and a portion of the outer extremity. On account of these mishaps the cost of the work at this locality has exceeded the estimate. The work now appears to be producing the desired effect, as it has caused the draught of water to take the desired direction, which should cut a good low-water channel through the middle bar. The channel depth at this locality for a few days last September, 20, 21, and 22, the river being low, St. Louis gauge about 7 feet, the channel depth at the head of the middle bar was as low as 5½ feet, but as above mentioned the channel then changed to a crossing, following hurdle No. 4, and a depth of 8 feet was maintained. At this time an attempt was made to deepen the channel at the upper crossing by means of the water jets from pile-drivers lashed together and the wrecking pump of the-steam-boat *T. F. Eckert*, but with no appreciable success.

The amount expended at this locality during the fiscal year ending June 30, 1889, was $104,495.96. (See plate II.)

CHESLEY ISLAND.

The work at this locality consisted in closing the chute to the west of the island below the mouth of the Maramec River. No work was done dur-

ing the fiscal year. The work is in good condition, and has succeeded in closing the chute so that it is dry, except a small portion at the lower end, at a 15-foot stage of the St. Louis gauge. (See plate III.)

JIM SMITH'S.

The project for the improvement of the river at this locality consists in the construction of contraction works. On account of the existence of a very persistent middle bar, it was determined to further extend the hurdles on the east side in order to close the chute to the east of this bar and concentrate the water in such a manner as to remove it. Two hurdles, No. 6 and No. 6½, were extended, work beginning May 9 on hurdle No. 6½. This was completed, with the exception of wattling, for a length of 700 feet from shore; hurdle No. 6 was completed for a length of 500 feet, when on June 11 the force and plant at this point were transferred to Pulltight to assist in the repairs at that point. This work will be continued as soon as the plant is available. The work was somewhat damaged by the May rise, which destroyed about 300 feet of completed work.

Amount expended during fiscal year ending June 30, 1889, was $14,079.66. (See plate III.)

SULPHUR SPRINGS.

The work at this locality is contraction work, the hurdles extending from the east bank. The project for this locality contemplated the extension and repair of the hurdles by bringing them out to the 2,500-foot line. They had been damaged by ice and drift at their outer ends. The plant being needed elsewhere the only work accomplished has been the wattling of hurdle No. 16, head of Foster's Island, up to the 22-foot stage. This hurdle, completed in 1888, had caused a fill of about 6 feet over the area affected by it.

The work at Sulphur Springs has very much improved the lower crossing. At this locality the boats at low water were frequently compelled to stop and back in making the crossing. The crossing is now easy and no difficulty is here encountered. The works are causing a strong tendency to remove the tow-heads opposite the town of Sulphur Springs. The amount expended during the fiscal year ending June 30, 1889, is included in the amount given for Jim Smith's. (See plate III.)

LUCAS'.

The project for work at this locality was adopted in 1888; it is a new work; the object to be attained is the contraction of the river on the Lucas crossing. This crossing has always given trouble to steam-boat traffic. A large portion of the water is wasted by flowing behind Calico Island, and a middle bar divides what is left into two or more channels of small depth and tortuous direction. Four hurdles were constructed here from the east or Illinois shore. No. 1, 1,500 feet; No. 2, 1,580 feet, No. 3, 1,890 feet, and No. 4, 2,550 feet in length, or a total length of hurdles of 7,170 feet. The work began here on March 6, and these hurdles were completed June 25; the distance between hurdles 1, 2, and 3, is 1,000 feet, and between 3 and 4, 1,500 feet. It is thought best not to extend this system until the effect of the work constructed is observed, as it may not be necessary to build more hurdles if these suc-

ceed in turning the water as desired; two, or possibly three more hurdles were contemplated in the original project.

The works are of too recent construction to give any data as to results produced, which can not be determined until the effects at low water have been observed. Amount expended during fiscal year ending June 30, 1889, was $67,427.60. (See Plate III.)

MATERIAL.

Brush and poles used were procured partly by hired labor and partly by contract from Mr. Nathan W. Tucker, at 95 cents per cord for brush and $1.47 per cord for poles.

Stone was procured by contract with the Grafton Quarry Company, at 40 cents per cubic yard.

Piles were obtained by contract with Mr. Nathan W. Tucker at prices varying from 5 to 7 cents per linear foot according to length.

Rope, iron, wire, bolts, spikes, etc., were obtained by contract from various parties as per abstract of bids appended. Subsistence and miscellaneous stores were purchased in open market on bids from various dealers.

SUPPLY DEPOT.

The supply and subsistence department was under the immediate charge of Mr. S. S. Van Norman. All supplies except brush, stone, and piles, as obtained were delivered at the depot, whence they were distributed on requisition to the various works. In addition to this function of the depot it was a general repair shop, where all repairs to plant, not requiring dockage, were made. During the season the steamer *General Gillmore*, three barges, and nineteen pile-drivers received extensive repairs; other plant ordinary repairs. Forty-two skiffs and twenty-five flats were built.

The present valuation of the property remaining to be distributed on installation account is given in the following table:

Class of property.	Balance June 30, 1888.	Debits.	Credits.	Balance June 30, 1889.
Barges, model and flat	$49,772.19	$10,702.49	$18,085.98	$42,418.70
Boat, machine-shop	1,613.14	119.38	.....	1,732.52
Boats, quarter	1,405.44	368.31	868.31	905.44
Boats, small	4,630.64	11,297.43	6,527.30	9,400.77
Drivers, pile	33,426.62	5,311.68	11,118.47	27,619.83
Machinery steamer *Humphreys*	6,000.00	.....	.....	6,000.00
Shanties, portable	11,587.05	888.28	2,773.26	9,702.07
Steamer *General Gillmore*	14,286.80	17,789.50	18,675.61	13,400.69
Tents	190.75	.....	.....	190.75
Ways for mattress	1,318.31	226.86	653.66	891.51
Supply depot	3,605.33	1,103.47	853.11	3,855.69
Tools and appliances	1,974.05	2,292.06	1,770.92	2,495.19
Boarding outfit	10,055.41	1,475.23	2,342.56	10,188.08
Office furniture	410.47	100.00	87.99	422.48
Surveying instruments	574.21	9.50	118.60	465.11
Photographic apparatus	200.48	.....	.....	200.48
Total	142,050.89	51,684.19	63,845.77	129,889.31

GAUGES.

The gauges at Grafton and Gray's Point were read daily during the season. The readings are appended, marked A.

CONDITION OF THE RIVER.

The channel depths, as furnished by the Mississippi and Ohio Rivers Pilots' Society, during the low-water season, are appended, marked B. The river was open for the whole year, not having been closed to navigation by ice during the year. The low-water season continued from the 1st of August, 1888, till about the 20th of May, 1889; the water fell to a reading of 7.80 feet on the St. Louis gauge on May 12; this is the lowest recorded water for this month since, and including, 1861, previous to which there are no records in this office.

REPORTS OF ASSISTANTS.

There are submitted herewith the reports of the superintending engineer, Mr. D. M. Currie, and of the assistant engineers, by reference to which all details and particulars can be obtained.

Plate IV shows details of construction for hurdle work.

ESTIMATE.

The amount that can be profitably expended during the year ending June 30, 1891, is $1,000,000. It is proposed to expend this sum in carrying out the programme heretofore adopted; that is, to carry on the work of improvement continuously from St. Louis down-stream, reclaiming land by building up new banks, thus reducing the river to an approximate width of 2,500 feet, alluvial banks to be protected from erosion. It is proposed by this means to obtain a channel of at least 8 feet at low water. The depth now is liable to become as small as 4 feet, or even less in some places, and less than 8 feet at every locality where the width is more than 2,500 feet. In my last report I asked for the same amount, but the river and harbor act of August 11, 1888, appropriated only $300,000. With this sum it was not possible to make the proper progress necessary for so important a work, and the steam-boat interests are suffering from such small appropriations.

This general statement of the proposed application of the appropriation is as specific as the nature of the case admits. The changeable character of the river renders it impracticable to give in advance the exact locality where works will be required.

The original estimated cost of this work as revised in 1883 was	$16,997,100
The aggregate amount appropriated to June 30, 1889, is	4,039,600
The amount expended to June 30, 1888, is	3,618,150

ABSTRACT OF APPROPRIATIONS MADE FOR PRESENT PLAN OF IMPROVEMENT.

By act of—	
March 3, 1873	$200,000
June 23, 1874	200,000
March 3, 1875	200,000
August 14, 1876	229,600
June 18, 1878	260,000
March 3, 1879	215,000
June 14, 1880	320,000
March 3, 1881	620,000
August 2, 1882	600,000
July 5, 1884	520,000
August 5, 1886	375,000
August 11, 1888	300,000

Money statement.

July 1, 1888, amount available		$95,658.37
Amount appropriated by act of August 11, 1888		300,000.00
		395,658.37
July 1, 1889, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1888	$173,827.34	
July 1, 1889, outstanding liabilities	17,980.74	
July 1, 1889, amount covered by existing contracts	32,507.95	
		224,316.03
July 1, 1889, balance available		171,342.34
Amount (estimated) required for completion of existing project		12,957,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1891		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Improvement of Mississippi between Illinois and Ohio Rivers. Annual Report of Major A. M. MILLER, Corps of Engineers. 1889.

Plate 1.

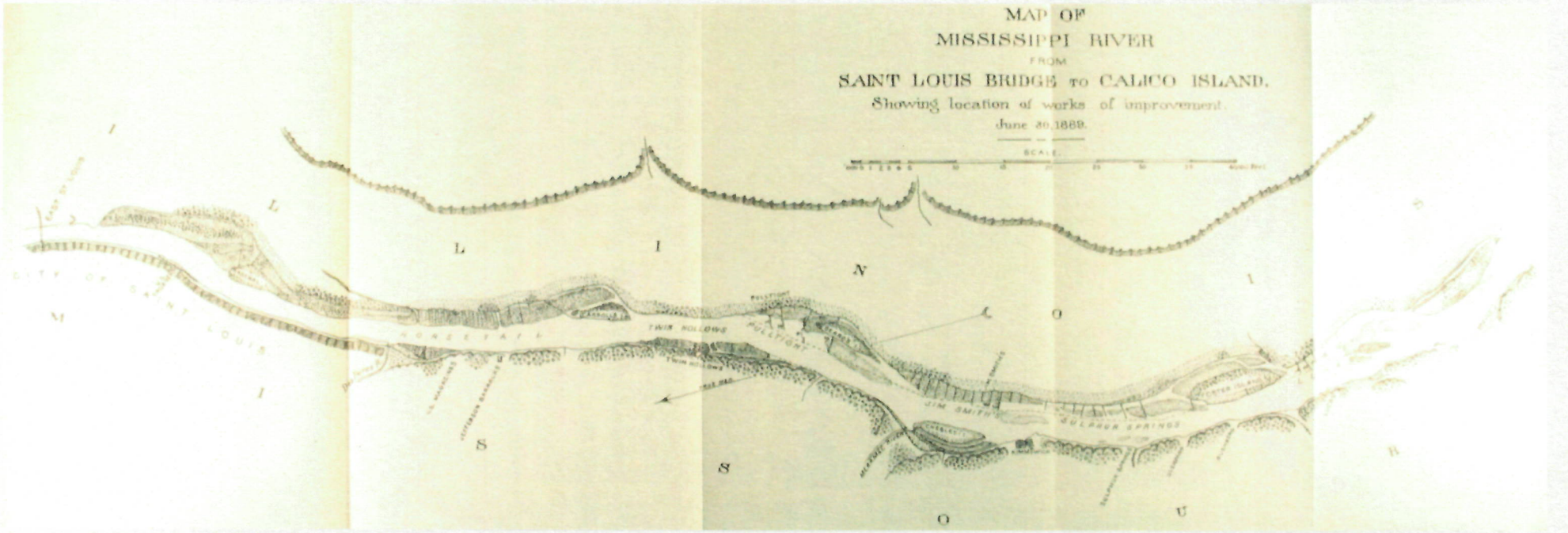
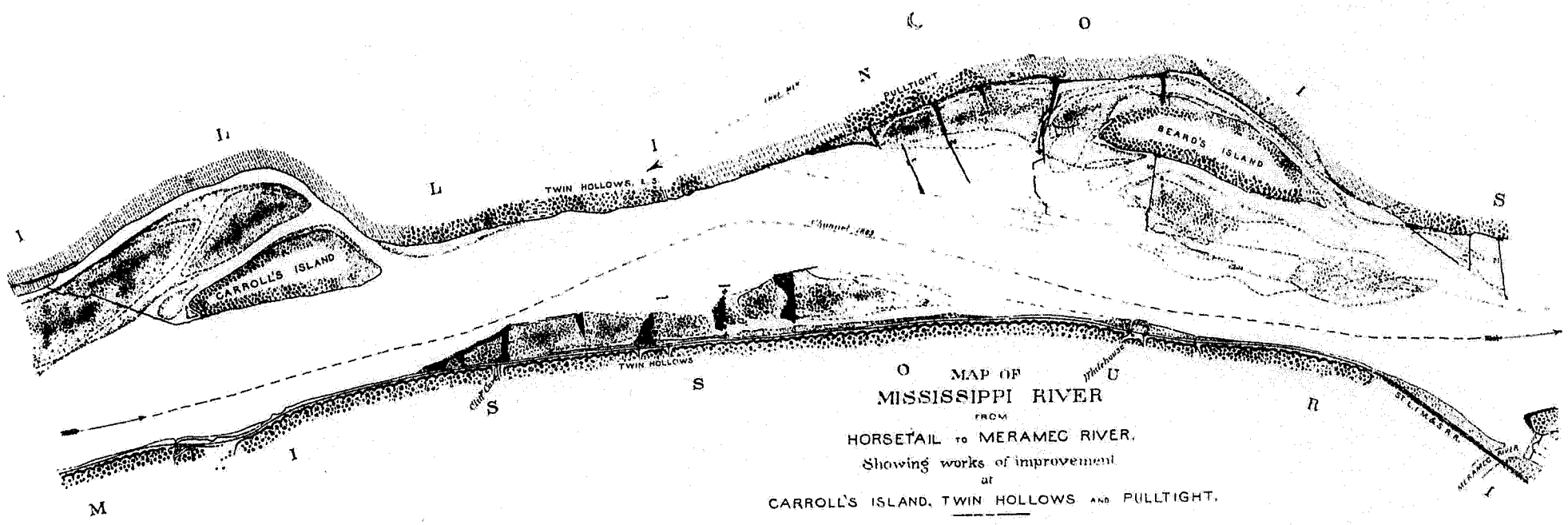


Plate 2.



MAP OF MISSISSIPPI RIVER

FROM

HORSETAIL TO MERAMEC RIVER.

Showing works of improvement

at

CARROLL'S ISLAND, TWIN HOLLOWS AND PULLTIGHT.

Bars are shown as they appear June 30 1889, at stage 11 ft above standard low water.
Bars as they appeared June 30, 1888, at stage 11 ft above standard low water, represented thus- - - -

Scale of Feet

U. S. Engineer Office, St. Louis, Mo. July 3, 1889.
To accompany my annual report for the year ending June 30, 1889.

A. M. Miller
Major Corps of Engineers.

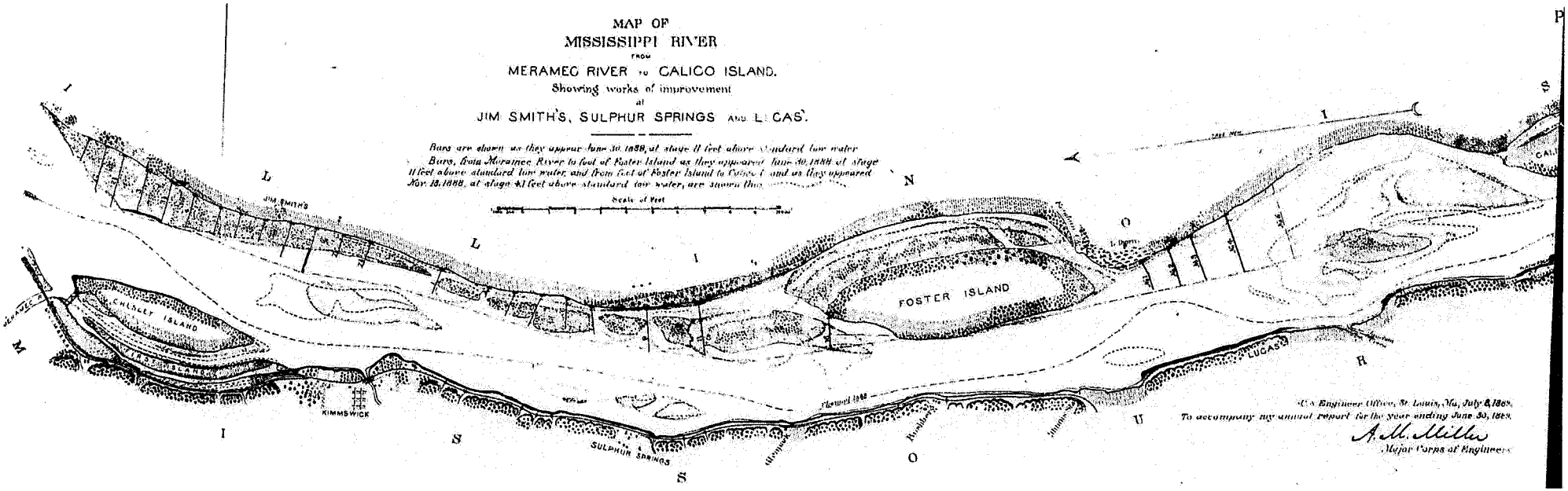
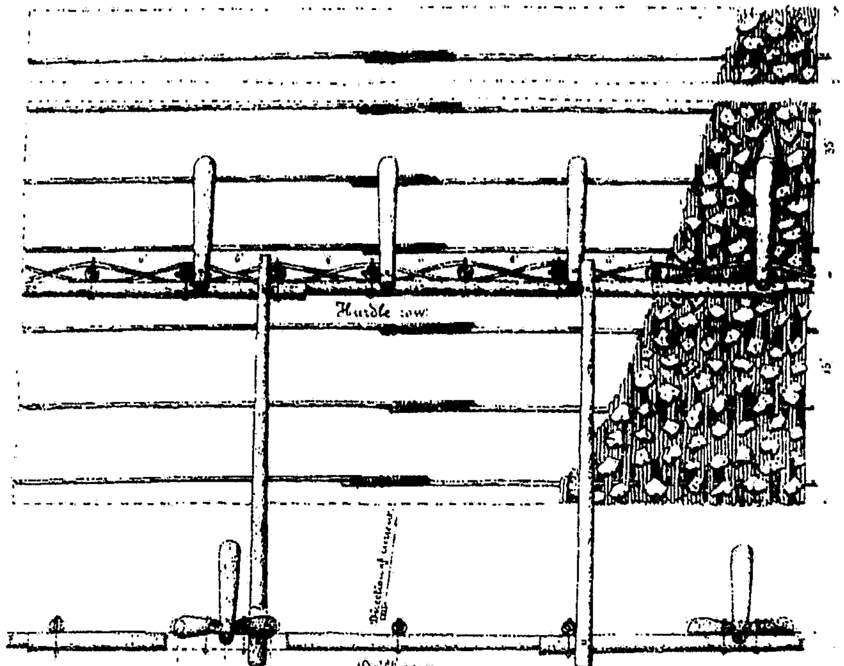
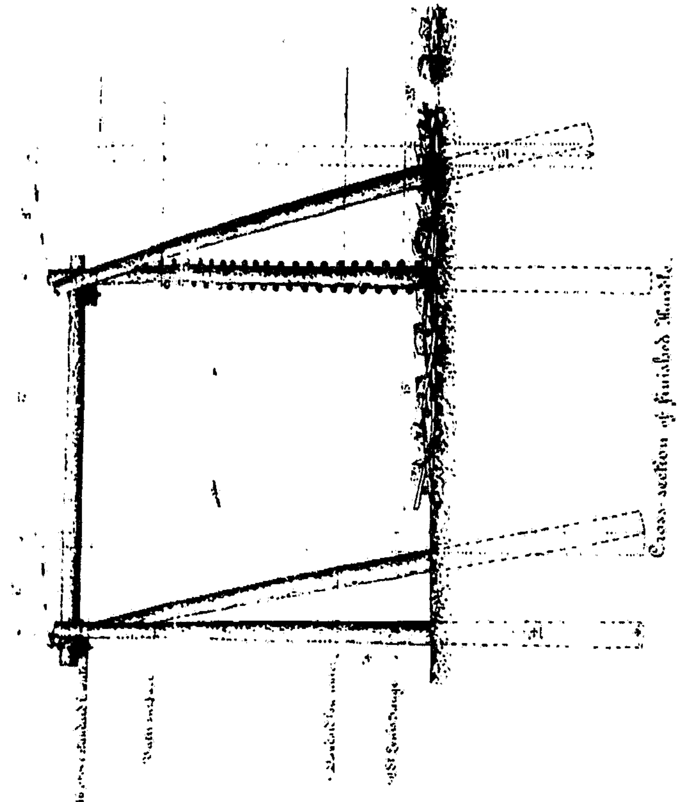
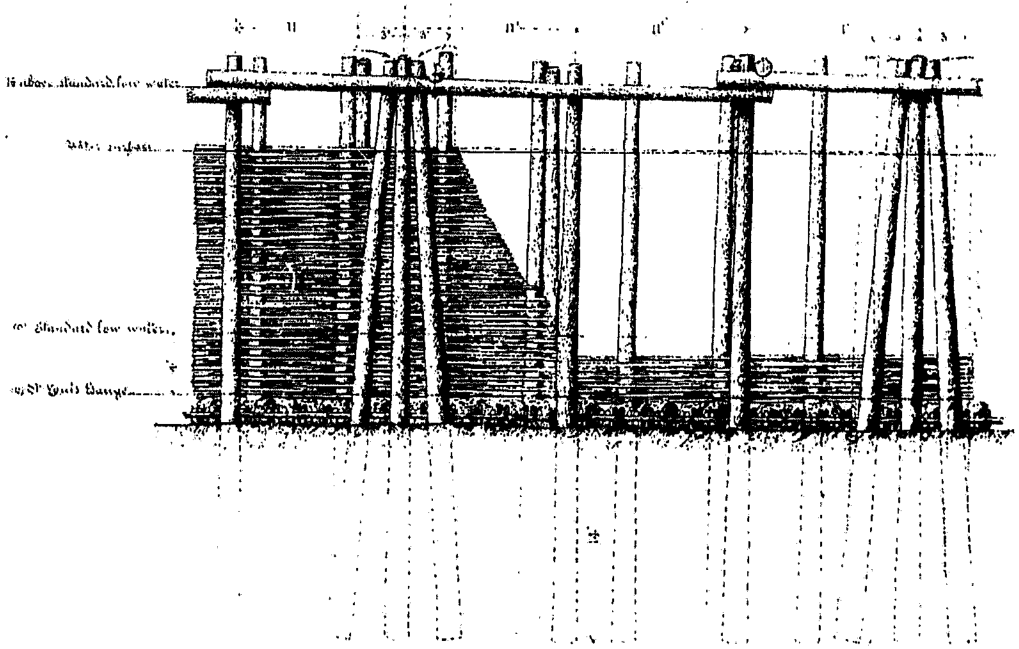

MAP OF
MISSISSIPPI RIVER
FROM
MERAMEC RIVER to CALICO ISLAND.
Showing works of improvement
at
JIM SMITH'S, SULPHUR SPRINGS AND LUCAS'.
Bars are shown as they appear June 30, 1888, at stage 11 feet above Standard low water
Bars, from Meramec River to foot of Foster Island as they appeared June 30, 1888 at stage 11 feet above standard low water, and from foot of Foster Island to Calico I. and as they appeared Nov. 13, 1888, at stage 8.1 feet above standard low water, are shown thus
Scale of Feet
JIM SMITH'S
CHESLEY ISLAND
FOSTER ISLAND
LUCAS'
KIMMSWICK
SULPHUR SPRINGS
MISSISSIPPI RIVER
U.S. Engineer Office, St. Louis, Mo, July 6, 1889.
To accompany my annual report for the year ending June 30, 1889.
A. M. Miller
Major Corps of Engineers

Plate 4.



Plan.





Up-stream view of finished Hurdle.

Improvement of Mississippi River between Illinois and Ohio Rivers.

Major A. M. Miller,
Corps of Engineers U. S. A.
Officer in Charge.

Details of Hurdle.

Scale of feet.

Notes.

[illegible] type of hurdle was used on all the works during the [illegible] ending June [illegible] 1888.

[illegible] cases, the drift row was carried 5ft. higher [illegible] piles in the [illegible] row to better protect the latter from heavy [illegible] driftwood.

[illegible] water curtain mattresses used in place of [illegible]. Above the curtain matt wattling is placed up to the 5ft. standard stage. [illegible] a sufficient deposit [illegible] been secured, the wattling is raised to the 16ft. standard stage.

The up stream end of the foundation mattress is placed [illegible] the drift row, and about 15ft. in front of the hurdle-row.

1890

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI RIVER—IMPROVEMENT OF THE MISSISSIPPI BETWEEN THE MOUTHS OF THE ILLINOIS AND OHIO RIVERS—IMPROVEMENT OF OSAGE AND GASCONADE RIVERS, MISSOURI.

Officer in charge, Maj. A. M. Miller, Corps of Engineers; Division Engineer, Col. C. B. Comstock, Corps of Engineers.

1. *Removing snags and wrecks from the Mississippi River.*—The navigation on this river was very much interfered with by the numerous snags, logs, etc., which were lodged in the channel, and to which a new accession was brought down on each rise of the river, thus constantly adding new and unknown obstructions to those already there. A large number of wrecks also occupied the channel and were very dangerous to the safety of passing boats.

For the removal of these obstructions appropriations were made as early as 1824, and the project consisted in building boats suitable for removing the snags, etc., and operating them whenever the stage of water was favorable for the work and funds were available.

The total amount expended for this purpose can not be definitely given, as previous to the appropriation made by act of March 3, 1879, a general amount was appropriated to be applied to several streams as their needs required. From March 3, 1879, when the first specific appropriation was made, up to June 30, 1889, $632,939.53 was expended for this purpose. The navigation of the river has been very materially improved by this method, and the danger of accidents to boats lessened.

During the fiscal year ending June 30, 1890, $85,263.27 was expended. Two snag-boats were employed between the mouth of the Missouri River and Bayou Sara, La., removing obstructions. The boats worked for a total of twelve months, removing 2,861 snags, cutting down 12,112 trees, removing 23 drift-piles, and 1 wreck, and traveling a distance of 10,797 miles, thereby greatly benefiting navigation and commerce.

Much needed repairs were also made to the snag-boats, and they are now in good condition to resume work as soon as the stage of water will permit.

An annual appropriation having been made for carrying on this work, no further estimate is submitted.

July 1, 1889, amount available		$32,971.95
Amount drawn under section 7, act of August 11, 1888		55,000.00
		87,971.95
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$82,061.12	
July 1, 1890, amount re-deposited	5,910.83	
		87,971.95
July 1, 1890, outstanding liabilities		419.11
July 1, 1890, amount available for fiscal year 1890–'91		100,000.00

(See Appendix Y 1.)

2. *Mississippi River, between the Ohio and Illinois rivers.*—The original condition of the navigable channel of this portion of the Mississippi River, before the work of improvement was begun, was such that the natural depth at low water was in many places from 3½ to 4 feet and the water was scattered by islands, which formed sloughs behind them, thus wasting the water available for low-water navigation.

The project for improvement adopted consists in closing these sloughs and, by contraction works, the concentration of the water between banks 2,500 feet apart, the object being thereby to obtain a depth of

8 feet in the channel between Saint Louis and Cairo and 6 feet between Grafton and Saint Louis at standard low water, or at a stage corresponding to a reading of 4 feet on the Saint Louis gauge.

The amount expended up to the close of the fiscal year ending June 30, 1889, was $3,905,153.51. The condition of the improvement during the year past has been such that during stages above 4 feet, except on very rapidly falling river approaching this stage, a depth of 8 feet has been maintained in the channel from Saint Louis to Lucas' Crossing, a distance of 30 miles, as far as the work of improvement had been carried on June 30, 1890.

The amount expended during the fiscal year ending June 30, 1890, was $129,268.78. No appropriation having been made for this year, little work could be accomplished. The work consisted principally in the continuation of the general plan, and has resulted in a very decided improvement of the channel as to direction and depth.

During the fiscal year work was carried on at the following localities:

Piasa Dam.—This work is situated above Alton. A portion of the dam, 1,100 feet long, was repaired and raised to a height 6 feet above low water, in order to concentrate the flow of water in the steam-boat channel; an opening was left between the Missouri shore and end of the dam, in order, if possible, to cut a channel along this shore, as this would rectify the channel. If this can be accomplished the present channel through the dam will be closed. The amount expended there was $5,577.11, and for this amount 2,604.9 cubic yards of stone placed in the dam.

Twin Hollows—West Side.—The work here consisted in the protection of the artificial banks formed by the contraction works. The work done consisted of 8,250 square feet of mattress protection placed and sunk below low water, and 63,500 square feet of upper bank protection, stone, was placed in position. The amount expended was $4,391.59.

Pulltight.—At this locality the repairs which were in progress at the close of the last fiscal year were continued and completed, and the hurdles strengthened where necessary. A large quantity of drift which had accumulated above the upper hurdle was utilized as a foot mat or protection by sinking it, building a brush mattress on the drift to receive the stone necessary for the purpose. The effect of this work has been very beneficial by concentrating and straightening the channel at this locality; 1,260 linear feet of hurdle was built and $30,806.87 expended during the fiscal year.

Jim Smith's.—At this locality hurdles and bank protection were repaired and extended. The object of the hurdle extension was to close the channel passing to the left or Illinois side of the middle bar, concentrating the flow on the west; 2,940 linear feet of hurdle was completed and 1,390 linear feet of bank protection, consisting of willow-mattress and stone placed in position; $31,359.81 was expended during the fiscal year.

Lucas'.—At this locality the work consisted in the repair of small gaps in the hurdles of last year and in the construction of two additional hurdles, Nos. 5 and 6; 4,050 linear feet of hurdle was completed in this locality in addition to the repairs above mentioned. The work at this locality was projected and begun in March, 1889, and has continued since. The object was to concentrate the water at Lucas' Crossing and close the false channel behind Calico Island. The work has been of great benefit to navigation, straightening and deepening the channel at this crossing; $60,629.05 was expended during the fiscal year.

Surveys.—During the year the survey of the river was continued to Brickey's Mill, a distance of 48 miles from the St. Louis Bridge, and a hydrographic survey of the river from the mouth of River Des Peres to foot of Calico Island made to show the changes in the channel and the effects of the improvements. The expenditure for surveys was $7,016.89.

A reference to the plates accompanying the report of the officer in charge will give a graphic representation of the progress and effect of these works.

The amount expended during the year was $129,268.78, and the total amount expended to June 30, 1890, was $4,034,422.29.

The original estimated cost of the work, as revised in 1883, was $16,997.100.

July 1, 1889, amount available		$171,342.34
July 1, 1890, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1889	$77,033.86	
July 1, 1890, outstanding liabilities	52.42	
		77,086.28
July 1, 1890, balance available		94,256.06
Amount appropriated by act of September 19, 1890		400,000.00
Amount available for fiscal year ending June 30, 1891		494,256.06
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		12,557,500.00

(See Appendix Y 2.)

3. *Gasconade River, Missouri.*—This river was greatly obstructed by snags, logs, and leaning timber, which materially interfered with navigation. Work was commenced on this stream in 1880, and the project adopted for its improvement consisted in the removal of snags and logs, the cutting of leaning timber, and the construction of contraction works at shoal crossings.

The amount expended to June 30, 1889, was $39,936.09, and at that time the navigation was much improved by the work done. During the fiscal year ending June 30, 1890, $2,130.26 was expended in removing obstructions from the bed of the river and cutting down leaning timber from the banks, also in constructing wing-dams and training-walls, thereby greatly improving the navigation of the river and enabling boats to run at lower stages of water than formerly.

The original estimate for the improvement of this stream was $50,000. New obstructions are continually forming, and it will require a small amount each year to keep the channel open at low water after the principal work has been done.

July 1, 1889, amount available		$2,563.91
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,135.34	
July 1, 1890, outstanding liabilities	.92	
		2,136.26
July 1, 1890, balance available		427.65
Amount appropriated by act of September 19, 1890		4,000.00
Amount available for fiscal year ending June 30, 1891		4,427.65

(See Appendix Y 3.)

4. *Osage River, Missouri.*—The navigation of this stream was very much interfered with by obstructions in the channel and shoal crossings. The original project, adopted in 1871, was to obtain a low-water

TABLE NO. 2.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, as required by section 7 of the river and harbor act of August* 11, 1888.

	1889.		1890.						Totals.
	Nov.*	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	
Office expenses	$403.10	$368.95	$552.00	$550.00	$550.00	$561.00	$375.00	$562.63	$3,922.68
Supervision	200.00	335.04	201.50	200.00	200.00	200.00	375.00	200.00	1,911.54
Expenses of snag-boat *H. G. Wright:*									
Crew	2,144.00	2,152.50	2,056.50	1,081.67	1,334.17	1,119.98	1,244.50	1,110.00	12,243.32
Outfit	25.00	622.77	465.00	2.50	2.00	2.80	.....	98.30	1,218.37
Fuel	311.50	409.00	468.72	.....	164.25	.....	.....	.....	1,353.47
Subsistence	.....	1,209.21	477.31	267.36	239.76	25.11	346.32	751.86	3,316.93
Supplies	.....	114.91	.....	.....	11.48	11.08	.....	16.74	184.81
Repairs	.....	231.19	188.34	.....	709.54	113.99	144.06	191.47	1,578.59
Miscellaneous	.....	.....	12.25	.....	.....	9.50	12.25	.....	34.00
Expenses of snag-boat *J. N. Macomb:*									
Crew	.....	2,109.00	2,075.00	3,545.01	807.17	891.00	932.17	1,275.40	1,694.75
Outfit	47.60	.....	45.09	2.50	.....	2.35	3.05	155.45	256.04
Fuel	472.00	392.25	996.68	812.55	.....	.....	.....	140.00	2,813.48
Subsistence	.....	421.14	1,165.17	361.17	120.00	14.65	156.96	443.39	2,684.48
Supplies	50.47	.....	78.91	7.75	.....	10.99	.....	52.22	200.34
Repairs	40.21	887.15	127.95	64.97	239.35	.....	276.05	3,693.80	5,329.54
Miscellaneous	.....	.....	.....	.....	12.25	.....	.....	12.25	24.50
Store-boat *Abert*	55.00	55.00	55.00	40.00	40.00	40.00	32.00	5.33	322.33
Totals	3,748.88	9,338.11	8,965.42	6,935.48	4,489.97	3,003.05	3,899.36	8,708.90	49,089.17

* This statement only includes money expended under section 7 of the river and harbor act of August 11, 1888.

Y 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN THE OHIO AND ILLINOIS RIVERS.

PROJECT.

The object of the improvement is to obtain a minimum depth at low water of 6 feet from the mouth of the Illinois River to St. Louis, a distance of 41 miles, and 8 feet from St. Louis to the mouth of the Ohio River, a distance of 191 miles, the natural depth at low water being in many cases from 3½ to 4 feet. The initial point of the work for the lower portion is St. Louis, the programme being to make the work continuous, working down-stream from that city. Work at detached points has also been carried on under allotments specially made by law for the improvement of landings and the protection of local interests.

The plan of general improvement contemplates a reduction of the river to an approximate width of 2,500 feet below St. Louis (the natural width being in many cases from 1 to 1½ miles) and the protection of alluvial banks from erosion. The methods employed are to build up new banks with the solid matter caught from the river itself by means of hurdles, and revetment of the banks, both new and old, when necessary.

ORGANIZATION.

The organization of the engineering staff during the season was as follows:

A supervising engineer was assigned to the general supervision of all the works and of the supply depot. His office was in St. Louis

and his duties were to advise and direct the resident engineers, and to have special charge of the supply of brush, stone, and piles, and of the tow-boat and barges engaged on the work.

The resident engineer was provided with quarters and an office at the work. His duties were to have immediate direction of the work of construction; to make such surveys and observations as might be required to keep the progress map, upon which all work was to be located as fast as constructed; to keep the journal and other records of the work; to prepare pay-rolls; to render quarterly property returns, semi-annual and annual reports to the officer in charge, forwarding them through the superintending engineer.

The superintending engineer was Mr. D. M. Currie. Resident engineers: At Pulltight for the first six months, Mr. William S. Mitchell; at Lucas, Mr. John O. Holman, who also had local charge of the repairs to the Piasa Dam; for revetment work at Twin Hollows, repairs at Pulltight, work at Jim Smith's, and procurement of brush, Mr. C. D. Lamb.

WORK ACCOMPLISHED.

No appropriation was made for this work for the fiscal year ending June 30, 1890; the amount available was the balance of the appropriation made by act approved August 11, 1888, about $17,000.

The work laid out for the expenditure of this amount was as follows: (1) the extension of the Lucas system of hurdles by the addition of two or more to the system; (2) the raising and repair of the dam at Piasa Island; and (3) general repairs to the works at Twin Hallows, Pulltight, and Jim Smith's, also the extension of some of the hurdles at the latter locality.

Plate I is a general map of the river from the Merchant's Bridge to Calico Island, and shows the location of these works with the exception of the Piasa Dam, which is above Alton; this dam is shown on Plate I to face page 1598, Report of the Chief of Engineers for 1881, and is marked E, C, F on that plate.

PIASA DAM.

This was a work originally placed for the purpose of throwing the channel between Piasa Island and the Illinois shore. After the dam was built it was found that the bottom between the island and the Illinois shore was composed of rock, and at some points did not give a depth of more than 30 inches at low water. The dam was built in 1877, was a submergeable one, and in order to repair the defect in its location a channel was cut through it for low-water navigation—this was about 1881. The opening for the new channel was made at the Missouri end with the expectation that the channel would naturally follow that side. A break was made by the ice nearer the Piasa end and this became the channel. Complaints having been received at this office from pilots and masters that the channel was becoming very difficult and shallow, a project was submitted and approved for the raising of the dam to 6 feet above low water, leaving both openings, for by this raising of the dam it was expected that more water would be forced through the gaps and a better channel formed.

The Missouri Gap was left open in hopes that the channel might pass down this way, which would be a decided improvement.

The raising of the dam has obviated the difficulty and no complaints have been received since; the channel still passes through the Piasa Gap, but is deeper and not so tortuous as before.

The portion of the dam raised was 1,100 feet in length and 5 feet wide on top. The plant used was towed to the locality by the United States steamer *General Gillmore*, and the work done by hired labor, stone being furnished by contract. Work was begun on August 17, and completed September 10, 1889; 2,604.9 cubic yards of stone was placed in position. Amount expended was $5,577.11.

TWIN HOLLOWS.

The work at this locality consisted in the protection from erosion of the bank formed by the contraction works erected here. Work was begun on October 1 and continued until the 21st of the same month; it consisted of both submerged and upper bank protection, 8,250 square feet of mattress or submerged revetment was placed, and 63,500 square feet of upper bank protection completed.

The work at this locality will require some regulation as soon as the Pulltight work has had its full effect. A quantity of water escapes over this bank and through sloughs which should be filled up; the lower portion will also probably require protection (see Plate I). Amount expended was $4,391.59.

PULLTIGHT.

The original project for this locality was to send the channel down the east side of the river by Beard's Island, making a crossing to the west side of Fine's Bluff, just above the mouth of the Maramec River. A study of this locality showed that the natural tendency of the river was to make the crossing above this point at White House, and at low stages there was a tendency to shoal; it was thought best to close the east side of the river by constructing hurdles, and throw as much water as possible into the White House Crossing, and improve and preserve this. With this view the system of Pulltight hurdles were prolonged in order to throw the channel to the western side at White House.

The work here for this year has consisted in repairing damages which the work sustained in the high water of June, 1889. This damage was caused by the large quantities of drift brought against the work; this drift by its great pressure breaks through the up-stream hurdle, and when the gap is made it is almost impossible to prevent the like accident to the hurdle below. The method adopted was to utilize the drift for a protection by sinking it in front of the upper hurdle. This was done by building a mattress of brush upon the floating drift, and loading this with sufficient stone to sink the mass; when this is accomplished the hurdle is very strong, and will resist any pressure which can not break the piles off. In these repairs 1,260 feet of hurdle was constructed.

This work was done in July; the hurdle remained in good condition throughout the fall and winter, but during the high water of spring, hurdles Nos. 1 and 2 lost some from the outer ends from scour. A tendency to cave in the bank below No. 1 was developed, and this bank for a distance of 100 feet below the hurdle was revetted.

The hurdles are now in good condition and have caused large deposits during the year (see Plate I). Amount expended was $30,806.87.

JIM SMITH'S.

The project for the improvement of the river in this locality consists in the construction of contraction works. On account of the existence

of a very persistent middle bar it was determined to extend the hurdles on the east side, in order to close the chute on this side of the bar. Operations were begun on hurdle work July 11 and continued till August 24, when the stage of water prevented further pile driving; 2,940 linear feet of hurdle was built. The new or artificial bank near hurdle No. 3, or the head of the Jim Smith system, showed some tendency to cave into the river, and this point was protected by a revetment in the usual manner. In all 53,100 square feet of mattress was built and sunk, and 1,390 linear feet of upper-bank protection placed. The average thickness of this latter was 9 inches. Amount expended was $31,359.81. (See Plate II.)

LUCAS'.

Work at this locality was begun in March, 1889. The project contemplates the contraction of the river to a width of 2,500 feet by means of hurdles built from the Illinois shore, the first hurdle being at Harrisonville just below the foot of Foster's Island.

The work this year consisted of repairs to the hurdles previously constructed, Nos. 1, 2, 3 and 4, and the building of two more lower down stream, Nos. 5 and 6; these were placed at intervals of 1,500 feet apart. No. 5 was extended for a length of 2,450 feet and No. 6 a length of 1,600 feet from shore until they both reached the shoal water at the head of Calico Island. The effect of the work at this locality has been the straightening and deepening of the channel at Lucas Crossing and the closing of the head of the Calico Island Chute at low-water stages. A very heavy deposit has been formed behind the hurdles and will continue to increase at each high-water stage. It is probable that no further work will be required at this locality other than possible repairs (see Plate 11). Amount expended was $60,629.05.

MATERIAL.

Brush and poles were obtained by hired labor.

Stone was obtained from the Grafton Quarry Company, of Grafton, Ill., at 40 cents per cubic yard delivered on barges. After their contract was completed, in open market at 45 and 50 cents, this latter was loaded on barges within a distance of from 10 to 16 miles from the work, and at these prices was more economical than 40 cents, when the towing was in some cases 70 miles.

Rope, bolts, and other material were purchased on bids from the lowest bidder, as needed.

Piles were obtained by contract with Mr. Nathan W. Tucker, at prices varying from 5 to 7 cents per linear foot, according to length.

SUPPLY DEPOT.

The supply and subsistence department was under the immediate supervision of Mr. S. S. Van Norman. All supplies, except stone, brush, and piles, as obtained, were delivered at the depot and thence distributed on approved requisitions to the several works. In addition to this function of the depot, it was a general repair shop, where all repairs to plant not requiring dockage was made.

Necessary repairs were made to the steamer *General Gillmore*, pile-drivers, barges, quarter-boats, and all floating plant.

The present value of the property remaining to be distributed on installation account is given in the following table:

Class of property.	Balance June 30, 1889.	Debits.	Credits.	Balance June 30, 1890.
Barges, model and flats	$42,418.70	$4,158.93	$15,183.93	$31,393.70
Boat, machine-shop	1,732.52	153.09	.....	1,885.61
Boats, quarter	905.44	436.37	1,341.81	.....
Boats, small	9,400.77	2,029.81	4,786.88	6,643.70
Drivers, pile	27,619.83	2,221.99	8,871.99	20,969.83
Machinery steamer *Humphreys*	6,000.00	.....	6,000.00	.....
Shanties, portable	9,705.07	744.32	2,588.28	7,861.11
Steamer *General Gillmore*	13,400.69	15,119.84	16,705.08	11,815.45
Tents	190.75	.....	.....	190.75
Ways for mattress	891.51	.....	891.51	.....
Supply depot	3,855 69	439.79	815.73	3,479.75
Tools and appliances	2,495.49	861.52	1,730.71	1,626.00
Boarding outfit	10,188.08	430.68	1,311.79	9,306.97
Office furniture	422.48	6.00	.....	428.48
Surveying instruments	465.11	6.50	.....	471.61
Photographic apparatus	200.48	.....	.....	200.48
Total	129,892.31	26,608.84	60,227.71	96,273.44

GAUGES.

The gauges at Grafton and Gray's Point were read daily during the year. The readings are appended, marked A.

CONDITION OF THE RIVER.

The channel depths as furnished by the Mississippi and Ohio Rivers Pilots' Society, during the year, are appended, marked B.

The river was open below St. Louis for the whole year, not having been closed to navigation by ice. This makes two successive winters of open navigation. The low water of this year, when the gauge at St. Louis was below standard low water, was from October 11 to November 3, 1889, and from December 9 to 12, 1889. The lowest gauge-reading was 3.50 feet on the St. Louis gauge on October 21, 1889, and the highest was 20.7 feet on June 30, 1890.

The season in general was a favorable one for navigation, small swells in the river keeping it at a fair boating stage. Heretofore the Anchor Line steamers generally laid up their larger boats and emp'oyed light-draught steam-boats during low water, this year the largest boats ran without losing trips.

REPORTS OF ASSISTANTS.

There are submitted herewith the reports of the superintending engineer, Mr. D. M. Currie, and of the assistant engineer, by reference to which all details and particulars can be obtained.

ESTIMATE.

The amount that can be profitably expended during the year ending June 30, 1892, is $1,000,000. It is proposed to expend this sum in carrying out the programme heretofore adopted; that is, to carry on the work of improvement continuously from St. Louis down-stream, reclaiming land by building up new banks, thus reducing the river to an approximate width of 2,500 feet, alluvial banks to be protected from erosion.

It is proposed by this means to obtain a channel of at least 8 feet at low water, the depth now is liable to become as small as 4 feet, or even less in some places, and less than 8 feet at every locality where the width is more than 2,500 feet.

This general statement of the proposed application of the appropriation is as specific as the nature of the case admits. The changeable character of the river renders it impracticable to give in advance the exact locality where works will be required.

The original estimated cost of this work, as revised in 1883, was	$16,997,100
The aggregate amount appropriated to June 30, 1890, is	4,129,600
The amount expended to June 30, 1889	3,905,153

ABSTRACT OF APPROPRIATIONS MADE FOR THIS WORK.

By act of—	
June 10, 1872	$125,000
March 3, 1873	200,000
June 23, 1874	200,000
March 3, 1875	200,000
August 14, 1876	229,600
June 18, 1878	240,000
March 3, 1879	200,000
June 14, 1880	300,000
March 3, 1881	620,000
August 2, 1882	600,000
July 5, 1884	520,000
August 5, 1886	375,000
August 11, 1888	306,000

Money statement.

July 1, 1889, amount available		$171,341.34
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$77,033.86	
July 1, 1890, outstanding liabilities	52.42	
		77,086.28
July 1, 1890, balance available		94,256.06
Amount appropriated by act of September 19, 1890		400,000.00
Amount available for fiscal year ending June 30, 1891		494,256.06
Amount (estimated) required for completion of existing project		12,557,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

ST. LOUIS, MO., *June* 30, 1890.

MAJOR: I have the honor to submit the following report upon the improvement of the Mississippi River in this vicinity for the fiscal year ending June 30, 1890, and to transmit, as part thereof, the report of the work at each locality by the assistant in charge at the close of operations.

The accompanying reports named in their sequence down-stream are: Piasa Dam, by Mr. John O. Holman; Twin Hollows—west side—Pulltight and Jim Smith's, by Mr. C. D. Lamb; Lucas, by Mr. John O. Holman.

The work was done by hired labor, with material procured by contract and purchase in open market, with the exception of 2,324.4 cords of brush, which was procured by hired labor.

The steamer *General Gillmore*, barges, pile-drivers, quarters, small boats, and other plant, used in connection with the work, are public property and subsistence was furnished in the field.

A survey from the mouth of the river Des Peres to the foot of Calico Island shows the improvement of the channel.

PIASA DAM.

A section of this dam, 1,100 feet long between the channel near the west bank and that used by steam-boats, was repaired and raised to the height of 6 feet above extreme low water to concentrate the water in the navigable channel and to break up the cross-current due to the flow over this section of the dam. On this work 2,608.9 cubic yards of stone placed as riprap was expended.

Further details are shown in the report of Mr. John O. Holman, superintendent.

TWIN HOLLOWS, WEST SIDE.

This work consisted in the repair and extension of the bank protection. The old work had settled from 1 to 3 feet between distances of 400 feet and 765 feet below hurdle "O."

The protection was completed below hurdle O to a distance of 1,000 feet, and from 1,525 feet to 1,700 feet. The bank was protected up to 10 feet above extreme low water between points 1,700 and 1,825 feet from the hurdle. The space between distances 1,000 and 1,525 feet from the hurdle is protected by hurdle No. 1.

Further details are shown in the report of Mr. C. D. Lamb.

PULLTIGHT.

At Pulltight repairs which were in progress at the beginning of the year were finished and the hurdles were strengthened where necessary.

The piling on hurdle No. 1 was extended 75 feet to the river end of the line. The line was re-enforced by sinking drift-wood above the piling to a distance of 1,063 feet from shore. The bank to a distance of 100 feet below the line was graded and revetted.

The gap in hurdle No. 2 was closed, the line was extended to its full length, the 500 feet next to the river end on account of shoal water, with only the drift row of piling and the mattress.

The gaps in No. 4 were closed and the line was strengthened with braces and stringers.

These hurdles have induced large deposits within their inclosures, and have as a consequence caused a large increase of the volume of water in the navigable channel during the lower stages of river.

Mr. C. D. Lamb was superintendent at the close of the year, and reference is made to his report for further details.

JIM SMITH'S.

At this locality hurdles and bank protection were repaired and extended.

Hurdles.—The wattling of No. 2½ was repaired, and a few piles were driven to connect the line with the high bank below and to close a chute in the rear of the revetment.

Nos. 6, 6½, and 7½ were extended 800 feet, 1,080 feet, and 1,060, respectively, from the new bank. In 6 and 6½ the bottom was from 2 feet to 8 feet above standard low water, and therefore they were not wattled.

In No. 7½ the mattress was extended 110 feet farther than the piling. Curtains were placed upon 800 feet of the line across the deep water near shore.

Bank protection.—The protection in the vicinity of hurdle No. 3 remained intact below that line, but above a cut had been made increasing in width from 20 feet near the hurdle to 75 feet at the head of the work.

A mattress 50 feet wide by 1,020 feet long was placed below low water and the bank revetted to its top from hurdle No. 2½ to a distance of 250 feet below No. 3.

For further details reference is made to the report of Mr. C. D. Lamb, superintendent.

LUCAS'.

At this locality the work consisted in repairing several small gaps in hurdle No. 4 and in constructing hurdles Nos. 5 and 6.

No. 4 was broken three times by scour due to swift current at low stages in a narrow channel along the shore. Each of these was repaired soon after it occurred, in which the length of the hurdle built aggregates 550 feet.

Hurdle No. 5, located 1,500 feet from No. 4, and No. 6, located 1,500 feet farther below and parallel with it, were built to distances of 2,450 feet and 1,600 feet, respectively, from shore.

Reference is made to the accompanying report of Mr. John O. Holman, superintendent, for forms of construction and other details.

FORMS OF CONSTRUCTION.

In both hurdles and bank protection changes in forms and methods of construction have been adopted after experimental trial.

The hurdle described in Mr. Holman's report of Lucas' is a type of the latest form used. In this form the drift row consists of clumps of piles high enough to prevent the passage of drift-wood at stages below bank full, which brings the tops of the piles to about the 25-foot stage above extreme low water. The mattress is hung to the lower piles of these clumps by yokes, and the piles and braces of the hurdle-row are driven through it. This places the hurdle in a condition to resist drift sooner than could be done under the construction formerly used. Where there is considerable depth with swift current the line has been secured by sinking drift above it.

To prevent rapid scour by currents parallel with the line, a mattress is placed above the drift row, and in excessive depths of water the piles are stiffened by placing a stringer at the middle of their exposed length, or at the surface of the lowest water during their construction.

Sinking drift, placing mattress above, and additional stringers are precautions used only in case of necessity.

Bank protection has been changed in the method of building the low-water mattress, rather than in its form.

The mattress barges having become unserviceable were dropped, and mattresses are now built upon ways made by lashing together a sufficient number of small flats with ways to make the desired width. The plant to be handled in construction is reduced to a minimum, and the flats are readily hauled out of reach of ice in winter, or of other danger when not in use.

Very respectfully, your obedient servant,

D. M. CURRIE,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. JOHN O. HOLMAN, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1890.

MAJOR: I have the honor to submit herewith the following report of operations at Piasa Dam for the fiscal year ending June 30, 1890:

A portion of the dam 1,100 feet in length was raised to a height 6 feet above low water with a top width of 5 feet.

The plant for this work was towed to the dam by the steamer *Gillmore*, August 15. On the 17th work was begun at the Missouri end, raising a ridge nearly to the 6-foot stage from the Missouri shore channel to the steam-boat channel near the middle of the dam. The work was again changed to the Missouri end August 26, completing the dam to the required height and width, reaching the steam-boat channel September 10.

The following table gives the location of the work done and the openings in the dam by referring to stations of 100 feet in length measured from the Missouri end:

Station 0. Highest point Missouri end of dam.

Station 0.70 to 4.70. Opening made in 1882; average depth, 7 feet below low water.

Station 4.70 to 5.25. Portion of dam not raised; surface exposed at low-water stage.

Station 5.25 to 15.25. Portion of dam raised 6 feet above low water.

Station 15.25 to 18.75. Present steam-boat channel; average depth, 10 feet below low water.

Station 18.80. United States Light.

Station 18.75 to 19.75. Portion of dam raised island side of channel.

Station 31. Island end of dam.

Total amount of stone expended was 2,604.9 cubic yards. The plant was taken to the fleet September 10.

A sketch of the locality accompanies this report. The slope of the river between Grafton and the dam, a distance of 9 miles, varied 0.5 foot between August 10, when the Missouri River was rising, and the 29th, when both the Mississippi and the Missouri rivers were falling.

I remain, very respectfully, your obedient servant,

JOHN O. HOLMAN,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1890.

MAJOR: I have the honor to submit the following report of operations at Twin Hollows, West Side, during the fiscal year ending June 30, 1890:

The work at this place was begun October 1 by a small force towed up from Jim Smith's, and consisted of repairs and extension of the protection begun in 1886.

The old work was found in good condition, though it had settled or slid from 1 to 3 feet between stations 4 and 7.65, the O being at hurdle No. 0.

The medium stage mattress above and below hurdle No. 0, which was left uncovered in the fall of 1888, was first revetted, and the protection was then repaired down to the lower end of the old revetment at station 7.65. The protection was then completed down to station 1000, or to the lower end of the medium stage mattress placed in 1888. Between this point and hurdle No. 1 the bank is so filled with drift that no erosion has been observed there since 1886.

Below hurdle No. 1 the bank is in good condition down to No. 3, except for a short distance below station 15 where the bank has been cut away for about 50 feet inside the foundation mattress of the old primary hurdle which protects the bank below as far down as hurdle No. 3.

A mattress was placed between stations 15.50 and 18.25 to prevent further erosion at low stages, and the bank was then revetted up to a 20-foot stage from station 15.25 to station 17 and to a 10-foot stage from that point to the lower end of the mattress at station 18.25.

The work was completed October 21 when the force was discharged and the plant towed into harbor at Bushberg.

The amount of work done during the season was as follows:

Mattress.—275 linear or 8,250 square feet built and placed.

Revetment.—1,575 linear or 63,500 square feet placed.

Very respectfully, your obedient servant,

C. D. LAMB.
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1890.

MAJOR: I have the honor to submit the following report of operations at Pulltight during the fiscal year ending June 30, 1890.

The work at this locality during the year was nearly all done in July, 1889, and consisted mainly in completing the repairs begun during the spring to hurdles Nos. 1, 2, and 4.

On hurdle No. 1 the piling was extended 75 feet to bring the hurdle to its original length of 1,575 feet, 843 linear feet of mattress 47 feet wide was built on the drift above the hurdle, and this mattress together with a section 150 feet long, built during June, was sunk. The line has been thus re-enforced with sunken drift from shore to within 425 feet of its outer end.

The repairing of hurdle No. 2 was completed and the line was finished to a distance of 1,600 feet from shore or to within 500 feet of the point proposed for its outer end.

On the remaining portion of the line, the drift-piles were driven and stringered, and the foundation mattress was built and placed, but its completion was prevented by shoal water.

On hurdle No. 4 the closing of the breaks was completed and the old work was strengthened with additional braces and stringers, but the 100 linear feet of piling carried away from the outer end of the line was not replaced on account of the deep water and strong current at that place.

No wattling was done on any of the hurdles during the season.

Work was completed for the half year August 5, when the force was discharged and the plant towed into harbor at Bushberg.

The hurdles remained in good condition through the winter, and have been but little injured during the spring. About 250 linear feet of piling was carried away from the outer end of No. 1, and 60 feet of the unbraced drift-row on the outer end of No. 2 was overturned. The revetment below the drift-row at the shore end of No. 1 was also cut away and the bank considerably eroded for several hundred feet below.

Repairs were begun upon this part of the work May 17 by a small force transferred from the brush party. The bank was graded and revetted for 100 feet below

the hurdle. A mattress 70 feet long and 30 feet wide was built and placed on the drift above the line with its inshore end on the protection, and the hurdle-piles near shore, which were spaced wider than those further out, were wattled up to the stringers.

This work was completed May 26 and the force was then discharged.

Work was done on the hurdles during the year as follows:

Hurdle.	No. 1.	No. 2.	No. 4.	Total.
Piles driven ..... number..	363	326	1,092	1,781
Stringers placed ..... do....	83	115	252	450
Foundation mattress built ..... square feet..	5,760	53,575	20,600	79,935
Foundation mattress placed ..... do....	10,680	53,575	20,600	84,855
Drift mattress built ..... do....	41,250	.....	.....	41,250
Drift mattress placed ..... do....	48,350	.....	.....	48,350
Wattling ..... do....	600	.....	.....	600
Revetment ..... do....	2,800	.....	.....	2,800

The hurdles are now in good condition and have induced large deposits during the year, even with the clear water resulting from the prevailing low stages of river.

Very respectfully, your obedient servant,

C. D. LAMB,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1890.

MAJOR: I have the honor to submit the following report of operations at Jim Smith's during the fiscal year ending June 30, 1890.

Work was done at this locality during the year on hurdles and bank protection.

HURDLES.

Operations at Jim Smith's were resumed July 11, by the force which had been employed since June 5, in repairing hurdle No. 2 at Pulltight.

Work was first confined to the extension of hurdles Nos. 6 and 6½. No. 6 was completed July 27 to a distance of 800 feet from shore or 1,750 feet from the old bank of the river.

The old drift-row on No. 6½ was so damaged by the rise of June 1, that it was abandoned; the old hurdle-row was repaired for a drift-row and another line driven below it for hurdle-piles. Work upon this line was completed August 1, when it had been extended to a distance of 1,080 feet from shore or 1,920 feet from the old bank.

No work was done on No. 7 as the water was too shoal to admit of extending the line to the desired length, but the extension of No. 7½ was begun July 18 and continued until August 24, when the line had been completed as far out as the low stage of water would allow. The piles were driven to a distance of 1,060 feet from shore, but no braces could be placed for 85 feet at the outer end of the hurdle row on account of shoal water. The mattress was built out upon the bar to a point 110 feet beyond the end of the piling, and curtain wattling was put in across the deep water near shore. These curtains were placed on 400 feet of line with their tops at an 8-foot stage.

No wattling was placed on hurdles Nos. 6 and 6½, as the bottom on these lines was from 6 to 12 feet above low water.

A few piles were driven at hurdle No. 2½ to connect the line with the high bank below and close the chute through which, at high stages, a considerable body of water passed down behind the protection built in that locality.

These piles were wattled up to a 20-foot stage and the wattling at the outer end of No. 22 was repaired.

The amount of work done on each line is shown in the following table:

	Hurdle line.				Total.
	No. 2½.	No. 6.	No. 6½.	No. 7½.	
Piles driven ..... number..	26	394	418	589	1,427
Stringers placed ..... do....	4	87	94	112	297
Mattress built and placed ..... square feet..	.....	21,000	30,100	81,900	133,000
Wattling placed ..... do....	4,680	.....	.....	6,200	10,880

BANK PROTECTION.

The old protection at Jim Smith's has remained in good condition below Hurdle No. 3, but above that line the bank has been cut away inside the revetment: 20 feet just above the hurdle and 75 feet at the head of the mattress.

To prevent further scour at high stages a mattress 50 feet wide was built on flats and placed with its inner edge at a 6-foot stage from Hurdle No. 2½ to within 120 feet of No. 3, or as far down stream as the flats could be handled inside the old revetment. The bank was then graded and revetted from the inner edge of the mattress to its top between Hurdles Nos. 2½ and 3, a distance of 1,140 feet, and from the old revetment to the top of the bank for 250 feet below No. 3, 1,020 linear or 53,100 square feet of mattress was built and placed, and 1,390 linear or 59,000 square feet of revetment placed.

The amount of stone used in revetment was 1,640 cubic yards, showing that the average thickness of the riprap was 9 inches.

The work was completed and the plant towed to Twin Hollows on the 30th of September.

Very respectfully, your obedient servant,

C. D. LAMB,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. JOHN O. HOLMAN, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1890.

MAJOR: I have the honor to submit herewith the following report of the operations at Lucas for the fiscal year ending June 30, 1890:

The work at this locality was on Hurdles Nos. 4, 5, and 6. No. 4 was constructed towards the close of the previous year, but a continued scour at the shore end caused several breaks, which were repaired during the fall of 1889 and again in the spring of 1890. The only other change in Hurdles Nos. 1, 2, 3, and 4 was at the river end of No. 4, where 100 linear feet were carried away by the channel current. Hurdles Nos. 5 and 6 were driven parallel to the upper ones; Nos. 1, 2, and 3, separated by distances of 1,500 feet between Nos. 4, 5, and 6.

The length constructed on each hurdle with the amount of work done is given in the following table:

Hurdle.	No. 4.	No. 5.	No. 6.	Total.
Constructed ..... linear feet..	550	2,450	1,600	4,600
Piles ..... number..	226	635	438	1,299
Braces ..... do....	87	461	311	859
Stringers ..... do....	76	186	121	383
Mattress ..... square feet..	76,995	246,750	132,475	456,220
Revetment ..... do....	19,725	7,700	7,000	34,425
Wattling ..... do....	7,650	13,050	13,190	33,890

The first break in No. 4 hurdle, caused by the scour at its shore end, occurred in August. It was repaired during the same month, from the 16th to the 22d, by Mr. C. D. Lamb, superintendent. The foundation mattress which, in some places, was suspended 8 feet from the bottom, was resunk and heavily loaded with stone. The

loosened piles, for a length of 100 feet, were redriven and a curtain mattress placed on the hurdle row.

The second break was 200 feet in length, extending from the caving shore-bar to the first break. It was closed November 25 to December 9. A foundation mattress 50 feet in width, with its up-stream edge 10 feet above the drift row, was placed across the break. The caving-shore bar was also protected by a mattress and riprap for a length of 320 feet, 145 feet above and 175 feet below the hurdle row.

The third break, which took place during the winter, carried away all of the piling used in closing the second one, the scour extending 50 feet into the shore bar, destroying the shore protection work. This break, 250 feet in length, was closed during the spring season's work, which began March 4. The shore protection was made much larger than usual, the mattress and revetment above it extending 350 feet above and 105 feet below the hurdle row, with an average width of 90 feet for the mattress and 35 feet for the revetment. A very light curtain mattress was placed on the hurdle row, with its top at the 8-foot standard stage.

The form of hurdle used on Nos. 5 and 6 was nearly the same as that employed in the construction of the upper four. Across the shore channel of about 800 feet in width both Nos. 5 and 6 were built stronger than over the middle bar.

In this deep water, from the shore to the bar and also at the river end of No. 5, the drift piles were placed 8 feet apart with a double row of stringers placed on them, one at the water surface, which during the working season averaged an 8-foot standard stage, and one at the 21-foot stage, the height to which the drift row was carried. In the hurdle-row piles were spaced 6 feet apart with the stringers at the 16-foot stage. Brace piles were then driven below each drift and hurdle pile, and cross stringers, reaching from the drift to the hurdle row, placed at each joint of the upper drift row stringer. Bolts 1 inch in diameter were used to hold the braces and stringers in position. Over the bar the drift piles were spaced 10 feet apart with only the upper stringer used. The hurdle row was driven 22 feet below the drift row instead of 27 feet as in the deep water, with but half the number of hurdle braces and cross-stringers. The foundation mattress followed the drift row and was placed before the hurdle row was driven. It was held in position by yokes to the drift row braces during the construction and sinking. On No. 5, and across the deep water on No. 6, its width was 65 feet. For a length of 665 feet at the bar end of No. 6 the mattress was built 75 feet in width, with its up-stream edge 15 feet above the drift row. To prevent a scour along the drift piles of No. 5 from the strong in-shore current an extra mattress 30 feet in width was placed above the piling a length of 1,825 feet from the river end. A T-head mattress, 160 feet long by 80 feet in width was also placed just outside of the piling on No. 5 to prevent a scour around the end of the hurdle.

The protection for the shore ends consisted of a mattress 350 feet long by 80 feet in width, half above and half below the hurdle row, with revetment above it 20 feet in width.

Wattling was placed on the hurdle row from the shore to the 8-foot contour on the bar a length of 850 feet on No 5 and 1,150 feet on No. 6. The wattling was made in the form of grillage mattress with the cross poles spread 6 feet apart, to which was secured the single layer of brush, free from bushy tops, the brush being placed with from 2 to 3 inches space between the willows. These mattresses were made in lengths of 100 to 150 feet the width adjusted to the depth of water so that when placed the upper edge would be at the 8-foot standard stage with the lower edge resting on the foundation mattress. The curtains were then fastened in this upright position by wire wrapped around the poles and the hurdle piles.

The season's work closed May 23. The maximum number of persons employed during the year was, at the close of April, 149, of whom 148 were subsisted at the work in quarter-barges.

I remain, very respectfully, your obedient servant,

JOHN O. HOLMAN,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1890.

MAJOR: I have the honor to submit the following report on procuring brush during the fiscal year ending June 30, 1890:

No brush force was organized during the fall of 1889, as the small amount of brush required on the work, aside from that procured by contract, was cut upon the bank near the work.

Fifty cords were procured in this way at Fine's Bluff, on which the customary royalty was paid.

Work was begun for the spring season on February 14 at the lower end of Twin Hollows. Brush was procured here at the rate of about 50 cords a day until April 14, when, as all the brush suitable for construction had been secured, the plant was removed to Pulltight. The force was then reduced and work continued at the rate of 25 cords per day until May 16, when the force was transferred to the construction work at Pulltight.

No royalty was paid on the brush procured during the spring season. It was all cut from land made between the hurdles at Twin Hollows and Pulltight, as follows;

	Cords.
Twin Hollows—	
Between hurdles 3 and 4	309.6
Between hurdles 4 and 5	459.3
Below hurdle 5	826.7
	1,595.6
Pulltight—	
Above hurdle 1	40.6
Between hurdles 1 and 2	197.5
Between hurdles 2 and 3	391.1
Between hurdles 3 and 4	99.6
	728.8
Total for season	2,324.4

Very respectfully, your obedient servant,

C. D. LAMB,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. S. S. VAN NORMAN, SUPERINTENDENT.

ST. LOUIS, MO., *June* 30, 1890.

MAJOR: I have the honor to submit my report of operations at the engineer supply depot, connected with works of improvement under your charge, for the fiscal year ending June 30, 1890.

Following is a general account of work done on each class of plant:

Tow-boat.—New chimneys were placed on the steamer *General Gillmore*, and a water-closet, foot-walks on the roof, and two cabin-blinds repaired.

Pile-drivers.—All were calked at the rake ends and under the leads, and minor repairs to machinery made, besides preparing a supply of kevels, chocks, and timber-heads for use when needed.

Barges.—The log pumps on Nos. 1, 6, 11, 28, and 30 were replaced with gas-pipe pumps. Ninety feet of nosing were renewed on No. 11; 75 feet refastened, and the deck, together with the decks of Nos. 21, 22, and 24, patched.

Kevels and timber heads were prepared and stored for future use.

All the barges were calked above the water-line during the year as became necessary. Barge No. 14 and barge-flat No. 57 were condemned.

Quarter-boats.—The quarters of Nos. 5 and 7 were transferred to barges Nos. 22 and 24 and repaired, and the quarter-boats condemned.

Machine-shop.—The rake ends of the machine-boat were calked.

Mattress-barge.—The mattress-barge was condemned by the officer in charge during the year.

Small boats.—Twenty-one flats, 25 skiffs, and 7 yawls were repaired, and 103 flats, 47 skiffs, and 13 yawls hauled out of the river and stored at the depot.

Tools and appliances.—Six box-pumps, 41 nozzles, 6 wrenches, 56 hose-bands, 4 nipples, and 3 stadia rods were made, as were also cant-hook handles, pump-brakes and signal-poles as required.

Log pumps, barrows, blocks, brake-hooks, spanners, pile-chains, capstans, fire-rakes, pile-driver levers, coal-boxes and bolts were repaired as needed.

Portable buildings.—Seven and a half sections were removed from barge No. 14 to barge No. 18, and the office quarters on barge-flat No. 57 removed to barge No. 21, and all repaired.

Ten sections were painted and two sections transferred to the light-house department.

Boarding outfit.—Six water-cooler boxes were made, ice-boxes and camp-cots repaired, tables and bunks in quarters on barge No. 18 and kitchen and office outfit on barge No. 21 overhauled, and the boarding outfit on barges Nos. 2 and 18 stored at the depot.

Supply depot.—A fence 55 feet in length was built at the south end of the depot yard; cellar doors to subsistence store-house and drain-boxes leading from buildings to sewer renewed; the blacksmith and carpenter shops and oil-house painted, and bolts in gangway leading to wharf tightened.

In addition to the above all supplies and material required in the field, other than brush, piles, and stone, were issued from the depot.

Very respectfully, your obedient servant,

S. S. VAN NORMAN,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

Construction account, showing total cost of works to June 30, 1890.

Name of work.	Expended Prior to July 1, 1889.	Expended during fiscal year ending June 30, 1890.	Total cost to June 30, 1890.
Piasa Island Dam	$32,333.30	$5.577.11	$37,910.41
Piasa Island Dam, cutting channel	3,116.86	.....	3,116.86
Alton Dam	33,740.05	.....	33,740.05
Alton Dike	76,652.74	.....	76,652.74
Sawyer Bend, protection	96,803.63	.....	96,803.63
Venice Dikes	36,341.85	.....	36,341.85
Arsenal Island, protection	42,599.06	.....	42,599.06
Closing Cahokia Chute	119,958.21	.....	119,958.21
Channel opposite St. Louis	58,455.54	.....	58,455.54
Horsetail Bar, Dikes 1 to 5 inclusive	225,066.31	.....	255,066.31
Horsetail Bar, training-wall	81,253.28	.....	81,253.28
Horsetail Bar, hurdles	548,834.08	.....	548,834.08
Horsetail Bar, bank protection	40,993.55	.....	40,993.55
Carroll's Island, hurdle	4,093.58	.....	4,093.58
Twin Hollows, west side, hurdles	248,837.82	.....	248,837.82
Twin Hollows, west side, bank protection	26,978.96	4,391.59	31,370.55
Twin Hollows, east s de, bank protection	128,920.30	.....	128,920.30
Beard's Island, primary hurdle	7,166.24	.....	7,166.24
Beard's Island, bank protection	84,258.76	.....	84,258.76
Jim Smith's, hurdles	342,013.10	23,790.23	365,803.33
Jim Smith's, bank protection	.....	7,569.58	7,569.58
Pulltight, hurdles	309,971.70	30,806.87	340,778.57
Chesley Island, bank protection	64,416.04	.....	64,416.04
Chesley Island, hurdles	27,808.61	.....	27,808.61
Sulphur Springs, hurdles	177,964.24	.....	177,964.24
Lucas's, hurdles	67,427.60	60,629.05	128,056.65
Foster Island	44,296.02	.....	44,296.02
Fort Chartres Dam	36,812.86	.....	36,812.86
Turkey Island	24,463.85	.....	24,463.85
Kaskaskia, protection	66,465.62	.....	66,465.62
Liberty Island Dam	5,053.91	.....	5,053.91
Liberty Island, protection	45,129.40	.....	45,129.40
Devil's Island, Dike 1	65,871.17	.....	65,871.17
Devil's Island, Dams 1 and 2	66,526.88	.....	66,526.88
Menton Point, hurdles	33,436.37	.....	33,436.37
Cape Girardeau, primary hurdles	31,930.18	.....	31,930.18
Cairo, protection	160,439.82	.....	160,439.82
Removing obstructions	4,280.45	.....	4,280.45
Totals	3,470,711.94	132,764.43	3,603,476.37

Property and material account.

Class of property.	Balance July 1, 1889.	Debits.	Credits.	Balance June 30, 1890.
Barges, model and flat	$42,418.70	$4,158.93	$15,183.93	$31,393.70
Boat, machine-shop	1,732.52	153.09	.....	1,885.61
Boats, quarter	905.44	436.37	1,341.81	.....
Boats, small	9,400.77	2,029.81	4,786.88	6,643.70
Drivers, pile	27,619.83	2,221.99	8,871.99	20,969.83
Machinery, steamer Humphreys	6,000.00	.....	6,000.00	.....
Shanties, portable	9,705.07	744.32	2,588.28	7,861.11
Steamer Gen. Gillmore	13,400.69	15,119.84	16,705.08	11,815.45
Tents	190.75	.....	.....	190.75
Ways for mattresses	891.51	.....	891.51	.....
Supply depot	3,855.69	439.79	815.73	3,479.75
Tools and appliances	2,495.19	861.52	1,730.71	1,626.00
Boarding outfit	10,188.08	430.68	1,311.79	9,306.97
Office furniture	422.48	6.00	.....	428.48
Surveying instruments	465.11	6.50	.....	471.61
Photographic apparatus	200.48	.....	.....	200.48
Subsistence	1,296.52	12,201.11	12,383.15	1,114.48
Brush	1,705.00	11,420.31	13,125.31	.....
Piles	5,098.26	12,931.26	17,933.92	95.60
Stone	94.54	15,214.80	15,210.79	98.55
Rope	11,182.33	1,945.71	3,328.04	9,800.00
Wire	356.46	33.80	356.00	34.26
Iron	220.49	54.73	50	274.72
Nails	443.44	22.84	150.82	315.46
Spikes	286.44	86.66	241.38	131.72
Bolts, screw-clevises, etc	988.85	1,094.18	1,094.20	988.83
Lumber	578.89	170.13	263.87	485.15
Oakum	18.86	133.25	61.97	90.14
Coal	128.00	5,682.42	5,489.42	321.00
Ice	.....	2,063.84	2,063.84	.....
Miscellaneous material	1,385.70	539.74	1,530.86	394.58

Detail construction account, showing cost of works during the fiscal year ending June 30, 1890.

Labor, material, plant, etc.	Piasa dam.	Twin hollows W. S. protection.	Pull-tight hurdles.	Jim Smith's—		Lucas hurdles.
				Hurdles.	Protection.	
Labor, superintendence, etc	$1,061.93	$1,004.54	$7,455.14	$5,601.78	$1,686.04	$12,855.33
General expense	118.72	112.00	804.16	628.17	186.04	3,357.64
U. S. Engineer Office	178.02	168.00	1,194.56	940.80	280.56	2,381.36
Gauge readers	5.80	5.80	41.70	32.48	9.86	132.76
Telephone	51.50	51.50	370.30	288.40	87.50	1,138.30
Steamer Gen. Gillmore	414.09	221.40	535.76	674.10	250.38	1,689.30
Barges	.....	74.76	504.98	392.82	325.40	521.55
Pile drivers	.....	.....	2,034.48	1,484.21	.....	4,955.59
Quarter boats	277.76	.....	305.26	618.18	.....	140.61
Quarters	.....	141.96	415.98	301.95	250.12	555.71
Supply depot	18.71	17.65	126.80	98.84	29.82	487.20
Small boats	109.35	90.30	1,046.55	782.34	476.16	1,987.30
Tools and appliances	38.17	43.50	399.20	286.42	77.68	655.53
Boarding outfit	47.75	45.24	324.82	253.57	76.45	460.86
Subsistence	268.84	317.18	2,944.96	1,942.77	505.14	4,395.19
Brush	.....	102.40	1,787.00	1,818.58	809.25	8,608.08
Piles	.....	.....	5,225.48	4,607.93	.....	8,057.04
Stone	2,795.06	1,907.87	1,979.02	1,030.63	2,137.20	5,361.01
Rope	71.40	53.19	1,745.40	410.90	71.40	648.31
Wire	.....	.....	84.45	41.37	10.21	216.72
Nails	.....	4.48	18.56	8.37	4.46	107.14
Spikes	.....	.....	41.50	71.93	12.38	113.22
Bolts, etc	.....	.....	260.26	415.68	.....	418.26
Lumber	.....	.....	.....	16.50	.....	.....
Coal	10.00	.....	403.80	504.90	133.38	900.84
Ice	90.55	29.73	567.30	432.31	146.03	271.37
Oakum	.....	.....	.....	.....	.....	.69
Miscellaneous material	10.40	.....	189.45	103.29	4.12	203.14
	5,577.11	4,891.59	30,806.87	23,790.23	7,569.58	60,629.05

A.—*Record of gauge at Grafton, Illinois, and Gray's Point, Missouri, for fiscal year ending June 30, 1890. Height of water above plane 200 feet below St. Louis City directrix.*

GRAFTON, ILLINOIS.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	197.52	194.76	191.78	192.63	191.53	191.60	192.86	195.73	193.79	198.69	201.53	196.63
2	197.33	194.55	191.69	191.66	192.93	191.35	193.37	196.13	192.98	198.31	201.34	196.61
3	197.26	194.43	191.68	191.63	195.19	191.39	193.45	195.87	192.84	198.23	201.07	196.53
4	197.69	194.30	191.78	191.60	194.83	191.48	193.24	195.53	192.63	198.73	200.83	196.55
5	197.43	194.13	192.01	191.56	193.91	191.43	193.13	195.62	192.57	198.41	200.73	196.63
6	197.33	194.81	192.14	191.51	193.01	191.40	194.63	195.63	192.53	197.78	200.53	196.73
7	197.08	193.58	192.13	191.48	192.74	191.38	195.28	195.67	192.63	197.42	200.23	196.83
8	196.89	194.36	192.20	191.43	192.66	191.36	194.57	195.73	192.93	197.13	199.78	197.31
9	196.64	193.11	192.29	191.33	192.33	191.33	193.74	195.72	193.09	197.04	199.41	197.73
10	196.51	192.99	192.41	191.23	192.84	191.43	193.23	195.71	193.27	196.95	199.13	198.13
11	196.39	192.94	192.51	191.26	194.43	191.65	194.23	195.50	194.23	196.88	198.94	199.83
12	196.26	192.88	192.72	191.20	194.51	192.43	196.44	195.37	195.53	196.99	198.70	200.43
13	196.03	192.73	192.93	191.13	194.13	193.21	198.03	195.24	196.71	197.26	198.97	200.83
14	195.75	192.63	193.13	191.08	194.53	193.13	199.43	195.29	198.65	197.73	198.91	201.53
15	195.61	192.56	193.23	191.13	193.05	192.77	199.27	195.43	199.17	198.23	198.87	201.87
16	195.48	192.53	193.26	191.16	192.68	192.68	198.43	195.56	198.69	198.36	198.73	202.38
17	195.33	192.63	193.22	191.16	192.49	192.68	197.04	195.71	198.43	198.44	198.59	202.33
18	195.54	192.75	193.05	191.21	192.26	192.65	196.63	195.84	198.16	198.65	198.43	202.13
19	195.96	192.73	192.81	191.17	192.23	192.73	195.95	195.73	198.18	198.93	198.30	202.23
20	196.62	192.69	192.72	191.13	192.13	192.73	195.49	195.70	197.79	199.04	198.19	202.33
21	197.36	192.55	192.63	191.15	192.07	192.72	195.25	195.49	197.64	199.38	198.01	202.50
22	197.13	192.48	192.43	191.23	191.93	192.71	194.73	195.13	197.45	199.73	197.85	202.66
23	196.73	192.38	192.26	191.53	191.85	192.69	194.58	195.15	197.39	199.86	197.67	202.85
24	196.33	192.26	192.21	192.08	191.83	192.66	194.36	194.62	197.33	200.03	197.59	202.99
25	195.99	192.13	192.23	191.93	191.83	192.63	194.13	194.34	197.53	200.29	197.38	203.17
26	195.65	192.03	192.23	191.85	191.82	192.60	194.53	195.13	197.43	200.59	197.26	203.33
27	195.83	191.97	192 05	191.73	191.81	192.53	195.13	194.84	197.64	201.11	197.19	203.66
28	195.63	191.93	192 80	191.61	191.80	192.53	195.15	194.63	198.92	201.63	197.03	203.88
29	195.28	191.91	192.76	191.43	191.78	192.51	195.23	.....	199.85	201.83	196.94	204.13
30	195.13	191.81	192.73	191.30	191.73	192.48	195.28	.....	199.67	201.68	196.81	204.38
31	194.97	191.76	.....	191.21	.....	192.43	195.28	.....	199.03	.....	196.63	.....

GRAY'S POINT, MISSOURI.

1	105.36	102.21	95.26	94.26	92.76	96.21	94.86	100.36	103.31	110.26	109.56	101.36
2	104.96	102.01	95.06	94.16	93.16	96.06	99.56	100.36	103.71	110.16	109.01	101.26
3	104.61	101.66	95.06	93.96	92.86	95.96	100.71	100.56	103.91	110.36	108.06	100.76
4	104.11	101.21	94.96	93.86	93.76	95.76	100.16	100.71	104.16	111.16	107.26	100.46
5	103.26	100.81	94.96	93.66	96.46	95.56	100.36	100.96	104.41	112.36	106.56	100.26
6	102.76	100.66	94.96	93.56	97.61	95.16	100.66	101.26	104.76	112.66	105.76	100.66
7	102.36	100.06	95.26	93.51	97.23	94.66	102.76	101.36	104.96	112.26	104.96	101.36
8	102.06	99.46	95.51	93.41	96.71	94.26	104.86	102.11	105.16	110.96	104.36	101.51
9	101.91	98.81	95.26	93.31	96.26	93.86	105.06	102.26	105.31	109.36	103.86	101.56
10	101.76	98.46	95.11	93.21	95.86	94.26	104.76	102.21	105.46	107.66	102.86	101.66
11	101.56	98.16	94.96	93.16	95.66	95.11	104.46	102.11	106.66	106.66	102.56	102.31
12	101.31	97.86	94.96	93.06	96.86	94.66	104.86	102.01	107.31	105.86	102.06	103.61
13	100.91	97.76	94.96	92.91	99.06	94.66	106.36	102.16	106.96	104.66	101.76	104.51
14	100.06	97.71	95.16	92.76	99.91	95.06	106.96	102.66	106.96	103.66	101.96	105.46
15	100.66	97.66	95.36	92.66	99.96	95.66	109.86	103.16	107.91	102.86	102.06	106.76
16	100.46	97.51	95.86	92.61	99.56	96.26	110.36	103.36	108.21	102.36	102.41	107.16
17	100.31	98.31	96.66	92.61	98.86	96.26	109.81	103.51	109.86	102.41	102.86	107.21
18	100.46	99.01	96.96	92.61	97.96	99.06	109.36	103.46	109.76	103.06	102.66	107.36
19	100.41	99.76	97.21	92.56	97.06	95.86	107.96	102.86	109.16	103.31	102.36	107.41
20	100.56	100.06	97.16	92.56	96.56	95.66	107.36	102.01	108.16	103.31	102.36	107.61
21	101.46	100.11	96.86	92.56	96.11	95.36	106.36	101.36	107.41	103.56	102.11	107.76
22	103.26	99.76	96.56	92.56	95.66	95.21	105.64	100.71	106.86	104.11	101.46	107.66
23	103.76	99.51	96.46	92.56	95.31	95.16	104.46	100.46	106.41	104.46	101.36	107.56
24	103.61	99.16	96.16	92.56	94.96	95.16	103.56	99.96	106.16	104.66	100.96	107.26
25	103.26	98.56	95.66	92.61	94.66	95.06	103.16	101.76	106.01	104.66	101.01	107.66
26	102.16	97.96	95.11	92.96	94.46	95.01	102.16	103.16	106.06	106.46	101.36	107.86
27	101.91	97.36	94.91	93.21	95.16	94.96	101.56	102.46	106.41	107.66	102.36	107.61
28	102.16	96.76	94.76	93.16	96.16	94.91	101.31	102.51	106.76	107.46	102.46	107.41
29	101.66	96.26	94.66	93.06	96.06	94.76	101.31	.....	107.36	108.96	102.36	107.51
30	101.41	95.86	94.51	92.96	96.31	94.56	101.21	.....	108.26	109.66	101.56	107.91
31	101.86	95.56	.....	92.86	.....	94.41	100.66	.....	109.56	.....	101.36	.....

B.—*Depth of water (in feet) upon*

Date.	Stage above standard low water by St. Louis gauge.	Name of steamer furnishing report.	Direction.	Arsenal Island.	Quarantine.	Pullitight.	Twin Hollows.	Golden Gate.	Fine's Bluff.	Meramec River.	Jim Smith's.	Sulphur Springs.	Lucas'.	Forest Home.	Towhead.	Durfee's.	Salt Lake.	Salt Lake Point.	Fort Chartres.	Steamer Humphreys.
1889.																				
July 4	9.5	City of Monroe	Down	15	...	10½	...	...	15	...	...	...	10½	...	12	...	...	...	9½	...
4	9.5	City of St. Louis	..do..	15	...	...	12	...	...	...	...	...	12	...	...	...	...	...	9	...
6	8.8	Sidney Dillon	..do..	9½	...	...	9½	...	...	...	...	...	9½	9½	12	...	9	...	...	...
6	8.8	General Gillmore	.....	13½	15	...	9½	...	...	...	...	...	...	...	...	...	...	...	...	...
13	7.4	....do	.....	12	15	...	9½	...	13½	...	...	...	...	...	...	...	...	...	...	...
15	7	....do	.....	12	15	...	9½	...	...	...	...	...	...	...	...	...	...	...	...	...
16	6.9	....do	.....	...	...	...	...	...	...	...	...	13½	8	10½	9½	...	...	...	...	...
22	11.1	....do	.....	13	15	...	9½	...	16½	...	...	...	...	13½	13½	...	...	...	...	...
29	8.2	....do	.....	13	15	...	9½	...	16½	...	...	...	...	13½	13½	...	...	...	...	...
Aug. 5	7	....do	.....	13	15	...	9	...	16½	...	...	...	12	12	...	...	...	...	...	...
8	5.6	Port Eads	Down	12	...	...	8	...	10½	...	...	12	8	...	12	...	9	8½	...	...
10	5.1	City of Vicksburg	..do..	10½	...	...	7½	...	...	9	...	...	7	...	...	...	6	...	...	...
10	5.1	City of New Orleans	..do..	...	...	6½	...	...	...	...	...	9	7	...	9	...	8½	...	...	...
12	4.5	General Gillmore	.....	10½	10½	...	8	...	...	...	...	...	7	9	12	...	...	6½	...	...
15	4.5	John Gilmore	Down	8½	...	...	5½	8	8	...	...	9	5	8	8	7	8	6	...	...
16	4.9	Henry Lourey	Up	...	...	...	6	13½	12	...	...	13½	8	10½	9½	...	10½	...	...	...
19	7	Belle Memphis	Down	12	...	...	10½	...	...	...	...	...	8	13½	12	...	8½	...	...	...
19	7	General Gillmore	.....	10½	10½	...	9½	...	16½	...	...	...	7	10½	12	...	...	...	9½	...
20	7	....do	.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20	7	Arkansas City	Down	15	...	9½	...	...	...	...	...	12	9	...	10½	...	9	9	...	...
21	6.7	City of Baton Rouge	..do..	12	...	...	7	...	8	...	...	8	6½	7	9½	...	9½	7	...	...
24	5.5	My Choice	..do..	10½	...	7½	6	...	...	13½	9	12	7	9	9	...	...	...	10½	...
24	5.5	City of Vicksburg	..do..	12	...	...	6½	...	...	...	...	...	8½	10½	10½	10½	10½	9	...	...
26	4.3	Belle Memphis	..do..	7	...	6½	...	...	...	...	...	10½	6	9	9	...	8	7	...	...
27	3.8	City of Cairo	..do..	7½	...	6	...	12	...	10½	...	2½	6	...	...	...	8	6	...	...
29	2.8	Sidney Dillon	..do..	8½	...	...	5½	...	...	...	...	...	5½	7½	7	7	7½	7	...	...
29	2.8	General Gillmore	.....	8½	8½	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...
Sept. 1	1.8	City of New Orleans	Down	6½	...	6½	...	...	...	...	...	8	6	8	6½	6½	8	6½	...	...
2	1.7	General Gillmore	.....	6	8½	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...
4	1.6	City of St. Louis	Down	8	...	...	5½	...	...	...	...	...	5½	...	...	...	8	6	...	...
7	2.1	City of Vicksburg	..do..	7	...	...	5	...	8	...	...	9	...	8	7	8	8	6	...	...
10	1.8	City of Monroe	..do..	7½	...	5½	...	...	...	9	...	9½	...	9	7	...	6	6	...	...
11	1.8	General Gillmore	.....	6½	9	5½	...	...	...	...	...	...	6	...	...	...	...	...	...	...
19	4.6	....do	.....	9	...	8	...	...	...	...	...	...	8	...	...	...	...	...	...	...
26	1.8	Arkansas City	Down	6½	...	5½	...	...	7½	...	...	...	6	7½	6½	6½	9	5	5	...
27	1.7	General Gillmore	.....	6½	7½	5½	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Oct. 1	1	....do	.....	6½	7	5	...	...	...	...	7½	...	...	...	...	...	...	...	...	...
4	.8	City of Baton Rouge	Down	6½	...	...	5½	...	...	...	...	...	6½	...	5½	5½	...	...	5	...
5	.6	Sidney Dillon	..do..	6½	6½	...	5	...	6	9	...	7½	4½	7	5½	5	7	5	...	...
6	.4	E. M. Norton	..do..	7	6½	...	4½	...	...	...	7	8	7	8	5	6	5	5	...	...
10	.1	City of Monroe	..do..	6	...	5	...	...	...	...	...	...	...	...	...	6	...	5½	...	5
11	.0	New South	..do	6½	...	...	5	...	8	...	...	7½	5½	7½	5	5	8	...	...	...
12	.0	Arkansas City	..do..	6	...	...	5	...	7½	...	...	...	5	...	4½	6	5	5	5	...
12	.0	General Gillmore	.....	6	6½	5	...	...	...	...	7	...	6	6	...	...	7	...	...	...
13	—.2	E. M. Norton	Down	6	...	...	5	...	...	6	...	...	5	...	5	...	6	5	...	...
16	—.4	City of Cairo	..do..	5	...	...	5	...	6	...	...	...	4½	...	5	5	5	...	5½	...
16	—.4	City of St. Louis	..do..	6	...	...	5	...	...	...	8	8	5	...	6	...	8	5½	5½	...
20	—.4	E. M. Norton	..do..	6½	...	...	5	...	...	8	6½	...	6	7	...	4½	8	4½	6½	...
21	—.5	General Gillmore	.....	6½	6½	4½	...	...	...	...	7	...	...	...	...	...	...	...	...	...
28	.....	General Gillmore	.....	6½	6½	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
30	—.3	Annie P. Silver	Down	6	...	...	5	8	6	...	...	...	5	...	5	...	7	...	6	...
30	—.3	City of Monroe	..do..	6½	6	6	...	8½	...	...	8	...	6	7	6	...	8	6	5½	...
Nov. 2	.2	Arkansas City	..do..	6	...	...	7	...	9	...	...	...	6½	...	6	5½	...	5½	...	...
5	4.6	General Gillmore	.....	...	...	9½	...	...	...	...	...	...	10½	9½	8½	...	...	...	9	...
9	2.2	Belle Memphis	Down	...	...	...	8	...	...	...	...	...	8	...	6½	...	...	...	...	...
13	6.5	City of St. Louis	..do..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16	5.1	City of Monroe	..do..	8	...	...	8	...	...	10½	...	...	9	...	9	...	...	...	...	...
21	1.9	City of Cairo	..do..	7	...	...	7	...	...	10½	...	...	...	...	6	...	...	...	...	...
25	1	General Gillmore	.....	7	...	...	...	...	6	...	...	...	7	...	...	...	...	...	...	...
28	1	City of Cairo	Down	...	...	...	9	...	...	8½	...	...	9	...	...	...	...	...	6	...
Dec. 2	1	General Gillmore	.....	7	8	6	...	...	...	...	...	...	7	...	...	...	...	...	...	...
1890.																				
Jan. 21	6.5	City of Providence	Down	...	...	10½	...	...	...	...	...	...	10½	...	9	...	...	...	8½	8
22	5.3	Sidney Dillon	Up	9½	9½	...	8	10½	12	7	...	8	8	...	7	...	9½	6½	...	...
25	3	City of Monroe	Down	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
28	3.4	Jay Gould	..do..	9	9	...	5½	9	...	9	...	7½	7	9	7	...	9	...	...	6½
28	3.4	Sidney Dillon	Up	8½	9	...	8	...	...	7	...	8½	8½	9	6½	...	6	...	...	6
31	4	City of Baton Rouge	Down	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6
Feb. 1	4.3	Arkansas City	..do..	9	...	8½	...	...	...	...	...	...	9	...	9	...	13½	9	...	...
2	5	Jay Gould	..do..	12	...	...	12	...	...	13½	...	...	...	...	10½	...	13½	...	...	9
2	5	Sidney Dillon	Up	9	...	...	9	...	...	9	...	...	10½	...	9	...	...	...	...	9

the bars between St. Louis and Cairo.

Crooke's.	Establishment Creek.	Turkey Island.	Mudd's Landing.	Little Rock.	Ste. Genevieve Bend.	Ste. Genevieve Island.	Kaskaskia Cut-off.	Ste. Mary's River.	Block's.	Manscoe's.	Liberty Island.	Crawford's Landing.	Neeley's Landing.	Vancil's Landing.	Willard's.	Bainbridge.	Shineman's.	Kinney Point.	Belle Golden.	Devil's Island.	Jacket Pattern.	Goose Island.	Hacker's Bend.	Brooks's.	Buffalo Island.	Thompson's.	Eliza Towhead.	Greenleaf's.	Greenfield's.
...	...	...	...	...	...	...	...	...	10½	13½	16½	...	13½	10½	...	...	...	...	10½	...	...	9½	...	...	...	12	...	12	...
...	...	15	...	...	...	...	...	...	12	...	...	...	...	10½	...	...	...	...	12	...	...	12	...	...	...	...	...	15	...
...	...	8½	...	...	12	12	...	...	10½	12	12	...	12	9	...	...	...	12	9½	...	13½	8½	...	...	8	13½	13½	10½	10½
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	9	...	...	8½	...	...	...	8½	...	12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	8½	8	...	9	...	9	...	...	8½	10½	10½	...	8½	...	10½	...	9	7½	9	...	9½	7½	...	...	7	...	9½	7½	...
...	...	7	...	...	...	...	...	...	9	...	9	...	8	...	9	...	...	8½	...	...	...	7	8	...	...	7	8	...	...
...	...	8	...	...	8½	...	...	...	9	...	10½	...	8½	...	...	...	...	9	9	...	...	...	10½	7½	...	10½	8	...	...
...	...	8½	...	...	...	...	...	...	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	6	5½	...	9	7½	...	...	6	8	8½	...	6½	...	9	...	8	7	5	...	7	5	...	...	6	8	...	5½	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	9½	10½	12	...	...	...	...	...	...	9½	...	...	...	7½	...	...	...	...	7	7½	...
...	...	8½	...	...	16½	...	...	...	10½	12	10½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13½	9	...	...	...	...	...	...	...	...	...	...
...	...	10½	...	...	...	...	...	...	9½	...	12	...	...	...	10½	...	...	...	10½	...	...	7	...	...	8	...	...	10½	...
7	...	6½	...	...	10½	8½	...	...	8	9½	...	...	8½	...	9½	...	8	8	...	...	...	7	...	...	6	8	...	8	...
...	...	8	...	9½	...	...	...	...	9	9	...	...	...	...	10½	...	9	...	9	...	9	6	...	...	8	...	8	8½	...
...	...	...	...	...	...	...	...	...	9½	9½	9½	...	8½	...	...	...	...	8½	10½	...	...	8	...	...	...	...	...	9½	7½
...	...	7	...	...	9	7	...	...	7	...	12	...	6	...	8	...	7	7½	5½	...	6½	4½	8½	...	...	6	...	6	...
...	...	...	...	...	...	...	...	...	8½	9	...	9	7½	...	8	...	7	7	7	...	...	5½	...	5½	...	...	9	6	9
...	5½	5	...	7	8	7	...	...	6½	...	8	7	6	...	6½	...	7	6	6	...	...	4½	7	...	...	5½	6½	5	8
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	5½	...	9	9	7½	...	8	7	7½	8	8	6½	...	8	8	...	7	...	...	6½	4½	...	...	5	6	...	6	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	6	8	...	...	...	9	...	...	8	8	9	...	7	...	8	...	...	5½	7	...	...	5½	...	...	...	7	...	6	...
...	...	...	...	...	...	5½	...	...	7½	5½	9	...	6	...	7	...	...	7	...	...	8	5	7	...	...	6½	...	...	6
...	...	6	...	8½	7½	8	...	6½	...	6	8½	8	5½	...	8	...	7	6	7	...	...	4½	8	...	...	5½	...	5½	...
...	...	...	...	...	...	...	...	...	...	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13½	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	6	...	9	...	...	...	...	7	5	7	...	5½	...	6	...	6	6	7	...	7	5	...	...	...	6	7	5	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	5½	...	...	7	5	...	6	5½	...	...	...	6	...	6	...	6	6	7	...	...	5	7	...	...	5½	10½	6	8
...	5	5	...	8	7	4	5½	...	4½	5	7	4½	4½	...	5	...	4½	5	4½	...	...	4½	5	...	...	5	...	5½	7½
...	...	...	...	...	...	5½	...	...	5	5½	5½	6	6	...	6	...	5	5½	6½	...	...	6	...	...	...	7	...	...	6
...	...	...	...	...	...	...	...	5½	...	...	5	...	4½	7	5½	...	5½	6	...	...	6	4½	6½	...	...	6½	...	6	6½
...	5½	5½	...	8	6½	5½	6	...	5½	6	6	6	4½	...	7	...	6	7	5½	...	6½	4½	7	...	...	6	...	7	...
...	...	5	...	...	...	5½	...	...	5	5½	6½	5½	5	...	7	...	6½	6½	6	...	5½	4½	6½	...	...	6½	...	6½	...
...	5	5	...	...	7	6	...	5	...	...	...	...	5	...	...	...	6	...	5	...	...	4½	...	...	...	...	...	...	...
...	5	5	...	...	7	5	...	...	5	6	5	...	5½	...	6	...	6	...	6	...	...	4½	6	...	...	4½	...	4½	...
5½	...	...	...	...	...	5½	...	...	5½	5	5	...	...	...	5	7½	6½	...	5	5½	6½	4½	7	...	...	...	...	...	...
...	...	...	...	...	8	5½	...	...	5½	5½	7	5½	6	6½	6½	6	6	6	6	...	...	5	...	...	...	...	...	...	...
...	...	...	...	6½	7	5	6	...	5	5	6	...	5	...	6	...	6	...	7	...	...	4½	6	...	...	5	...	6	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	5	...	6	...	...	...	...	...	5½	...	...	...	7	...	...	...	5	5	...	...	...	5½	...	7	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	7	5½	...	...	7	...	7	6	6	...	6½	...	...	6½	...	6½	5	5	...	...	...	7½	...	7½	...
...	...	9½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	8	...	...	...	7½	...	...	...	...	...	...	...	...	7	8	...	...	...	...	8½	...
...	...	12	...	...	...	...	...	...	...	...	13½	...	...	...	...	...	...	...	...	...	...	9	...	...	...	...	...	10½	...
...	...	9	...	...	...	12	...	...	10½	...	...	...	...	...	...	...	...	...	...	...	...	8	...	...	...	...	...	...	...
7½	6½	7	...	...	...	8	...	...	8	9	...	...	...	...	8	...	8	8	...	8	...	7	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7	...	...	...	...	...	...	...	...	7	...	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	13½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9	...	...	...	...	...	...	...	...	...	...
...	7	...	10½	...	...	...	...	...	10½	...	10½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	5½	...	...	...	...	...	9	...	...	...	...	...	...	12	...	...	...	6	12	...	...	...	...	...	...	...	...	...
...	...	...	...	9	10½	9	9	...	5½	5½	6½	9	...	...	...	...	9	...	9	...	...	...	...	...	...	...	...	...	...
...	...	6½	...	...	9	...	...	...	6½	9	8	9	9	9	9	...	9	...	6	9	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	8	...	...	...	...	...	...	...	...	...	7	...	...	...	...	...	...	...	...	...	...
...	...	9	...	...	...	...	...	...	7½	...	...	...	...	...	...	...	...	...	8	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	10½	10½	...	...	10½	12	12	...	10½	...	...	...	10½	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	10½	...	...	...	10½	...	10½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

B.—*Depth of water (in feet) upon the bars*

Date.	Stage above standard low water by St. Louis gauge.	Name of steamer furnishing report.	Direction.	Arsenal Island.	Quarantine.	Pullight.	Twin Hollows.	Golden Gate.	Fine's Bluff.	Meramec River.	Jim Smith's.	Sulphur Springs.	Lucas.	Forest home.	Perry's Towhead.	Durfee's.	Salt Lake.	Salt Lake Point.	Fort Chartres.	Steamer Humphreys.
1890.																				
Feb. 8	7.4	City of Providence	Down	..	..	13½	..	..	..	10½	..	..	..	..	12	..	..	..	9½	..
18	6.7	Arkansas City	..do ..	..	..	10½	..	..	..	10½	..	15	15	..	13½	..	..	10½	..	..
22	6	City of Vicksburg	..do ..	10½	..	..	10½	..	10½	9	..	..	12	..	7½	..	15	7½	8	..
23	5.4	Oakland	..do ..	9½	..	..	8	..	..	10½	..	10½	..	10½	9½	..	9	8	..	..
24	5	Sidney Dillon	..do ..	..	9	..	10½	..	12	9	..	9	9	12	9	..	9	..	..	..
25	4.6	City of Monroe	..do ..	9	..	10½	..	..	..	10½	..	..	10½	..	8	..	..	7½	..	..
Mar. 1	4.4	Arkansas City	..do ..	9	6	..	6	..	..	7	..	7	..	..	9	..	..	6	..	..
10	1.4	General Gillmore	.....	7	7	7	..	..	..	..	6½	..	..	..	..	..	..	..	..	..
11	2.3	City of Vicksburg	Down	8	..	..	..	..	10½	9	..	9½	9	..	8	..	7½	..	..	..
14	7.4	City of St. Louis	..do ..	..	..	..	8	..	..	10½	..	..	..	..	9	..	9	..	..	..
20	8.7	City of New Orleans	..do ..	..	..	..	..	..	12	12	..	..	..	..	..	..	13½	..	..	..
20	8.7	General Gillmore	.....	13½	13½	13½	..	..	13½	..	13½	..	15	15	9½	..	..	..	10½	..
21	8.2	Sidney Dillon	Down	17	..	..	12	..	..	12	..	..	13½	..	..	..	10½	..	..	..
23	7.4	...do	Up	..	..	7½	..	..	16½	12	..	13½	12	13½	10½	9	..	..	..	..
25	7.7	City of Vicksburg	Down	..	..	..	9	..	..	15	..	..	12	..	10½	..	..	..	..	..
29	10	Belle Memphis	..do ..	..	..	..	15	..	..	16½	..	..	13½	..	12	..	10½	..	16½	..
31	10.5	General Gillmore	.....	13½	15	..	..	..	18	..	18	..	12	..	..	..	..	..	..	..
Apr. 8	10.8	....do	.....	12	15	..	..	..	19½	..	18	..	13½	17	18	..	..	..	13½	..
15	8.3	....do	.....	9½	13½	..	..	..	18	..	15	..	12	..	..	..	..	..	..	..
22	11.5	....do	.....	12	18	..	..	..	22½	..	18	..	16½	..	..	..	..	..	..	..
30	14.6	....do	.....	16½	18	..	..	..	..	..	21	..	18	..	..	..	..	..	..	..
May 6	11.7	... do	.....	13½	16½	..	..	..	22½	..	16½	..	18	..	..	..	..	..	..	..
10	9.3	Sidney Dillon	Down	10½	..	..	10½	..	16½	13½	..	13½	12	10½	9	..	9	..	..	..
11	8.8	Jay Gould	..do ..	9	10½	..	9	..	13½	..	..	..	..	10½	10½	..	10½	..	..	..
13	8.4	General Gillmore	.....	10½	13½	..	..	..	19½	..	13½	..	..	..	..	..	..	..	..	..
13	8.4	Sidney Dillon	Up	9	..	..	8	..	..	..	..	..	..	..	..	..	..	..	..	..
13	8.4	City of Monroe	Down	10½	..	17	..	..	..	15	..	..	15	..	12	..	12	..	..	..
14	9	City of St. Louis	..do ..	9	..	..	9	..	..	12	..	..	10½	..	..	..	..	..	13½	..
15	9.5	City of Providence	..do ..	12	..	10½	..	..	..	15	..	10½	12	..	..	12	12	..	10½	..
17	9.1	Henry Lourey	..do ..	9½	..	..	9½	..	..	12	..	..	9½	12	10½	..	13½	..	..	..
18	9.1	Arkansas City	..do ..	10½	..	9	..	..	..	..	..	..	..	..	12	..	12	..	..	..
20	8.9	General Gillmore	.....	12	12	..	..	..	18	..	16½	..	..	..	..	..	..	..	..	..
21	8.5	City of Vicksburg	Down	10½	..	..	9	..	..	..	..	..	10½	..	10½	..	8	..	..	..
24	8	Belle Memphis	..do ..	9	..	..	8½	..	..	..	..	..	10½	..	9	..	10½	..	..	..

between St. Louis and Cairo—Continued.

Crooke's.	Establishment Creek.	Turkey Island.	Mudd's Landing.	Little Rock.	Ste. Genevieve Bend.	Ste. Genevieve Island.	Kaskaskia Cut-off.	Ste. Marys River.	Block's.	Manscoe's.	Liberty Island.	Crawford's Landing.	Neeley's Landing.	Vancil's Landing.	Willard's.	Bainbridge.	Shineman's.	Kinney Point.	Belle Golden.	Devil's Island.	Jacket Pattern.	Goose Island.	Hacker's Bend.	Brooke's.	Buffalo Island.	Thompson's.	Eliza Towhead.	Greenleaf's.	Greenfield's.
		10½																	12										
									10½																				
9						12			12	12	10½								10½			9							
		7	10½			9½			9	9½					9	12			12	9									
			9			10½			9		10½	10½	12				12	12	12		13½	12							
									10½		12			12															
									9	9	9		12	9½			12		9½										
9									9		10½																		
	8½	8½							9		9																		
		13½																											
		9½																											
			10½			10½			13½		12	13½	13½						13½										
									12		12	10½																	
9									13½		12																		
18																													
		13½			13½				13½	13½																			
9				12	9½				10	15	9	9	13½	9			13½	13½	10½		8	9½			10½	16			
9									10½	13½	10½	10½	10½				13½	12	10½			9			13½	16½		12	
8½									10½		10																	16½	
12					12			10½			9½	12										9½			13½			16½	
									9													11							
									12		8				15		12					12		13½					
10½			12			10½			12			9½	12	12			12	12	12		12	12			10½		18	15	
			18			12																12			12				
10½						10½			12		12			12					10½			9½			12			16½	
									10½		10½	9		12			13½	15	9		12	9			10½			16½	

COMMERCIAL STATISTICS.

Receipts and shipments at St. Louis, Missouri, during the years 1887, 1888 *and* 1889.

Articles.	Receipts.			Shipments.		
	1887.	1888.	1889.	1887.	1888.	1889.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cement	4,449	5,344	6,876	.....	.....	.....
Coal and coke	85,662	96,208	88,845	665	7,605	1,701
Cotton (and products)	6,306	5,178	4,663	41	23	200
Groceries and dairy products	5,012	7,911	8,815	6,619	7,598	8,047
Hay, seeds, and grains (including flour, meals, etc).	118,255	100,384	96,265	454,586	342,200	538,329
Jute	4,683	2,724	3,473	.....	.....	.....
Live-stock (and products)	12,355	12,821	12,805	17,730	14,619	15,429
Lumber	213,105	130,855	127,695	6,876	13,085	6,470
Merchandise and sundries	323,643	325,548	281,579	131,216	112,904	131,546
Ores and metals (pig and manufactured)	83,356	32,738	31,663	15,015	6,748	5,885
Vegetables	7,732	8,062	7,986	1,654	2,260	2,612
White lead, oils, etc	948	670	756	1,805	2,265	1,799
Wines and liquors	151	174	102	816	772	647
Wool	328	193	162	37	36	35
Total	886,045	728,810	671,685	637,060	510,115	712,700

	1887.	1888.	1889.
	Tons.	*Tons.*	*Tons.*
Transferred by ferries across the river at St. Louis	2,529,401	2,351,881	2,717,760

Shipments down the river from landings between St. Louis and Cairo during the years 1887, 1888, 1889.

Articles.	1887.	1888.	1889.
	Tons.	*Tons.*	*Tons.*
Grain (including flour, meals, etc)	34,457	37,257	29,209

RECAPITULATION.

	1887.	1888.	1889.
	Tons.	*Tons.*	*Tons.*
Receipts and shipments at St. Louis	1,503,105	1,238,925	1,384,385
Transferred by ferries at St. Louis	2,529,401	2,351,881	2,717,760
Shipped from landings between St. Louis and Cairo	34,457	37,257	29,209
Totals	4,066,963	3,628,063	4,131,354

NOTE.—Increase of 503,251 tons for the year 1889 over the year 1888.

Arrivals and departures of steam-boats and barges at St. Louis during the years 1887, 1888, *and* 1889.

	1887.		1888.		1889.	
	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.
Steam-boats	2,361	2,328	2,079	2,076	2,195	2,211
Barges	1,272	.....	1,244	.....	1,474	.....

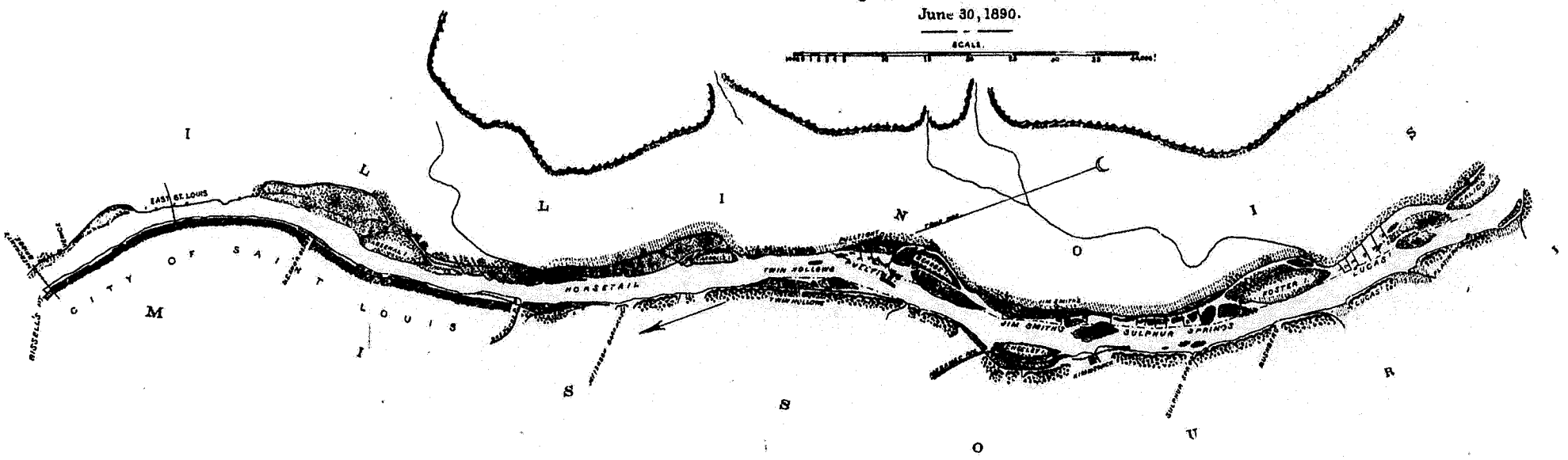
MISSISSIPPI RIVER

FROM

BISSELL'S POINT TO CALICO ISLAND.

Showing location of works of improvement.

June 30, 1890.



(2)

Plate 2.

MISSISSIPPI RIVER

FROM

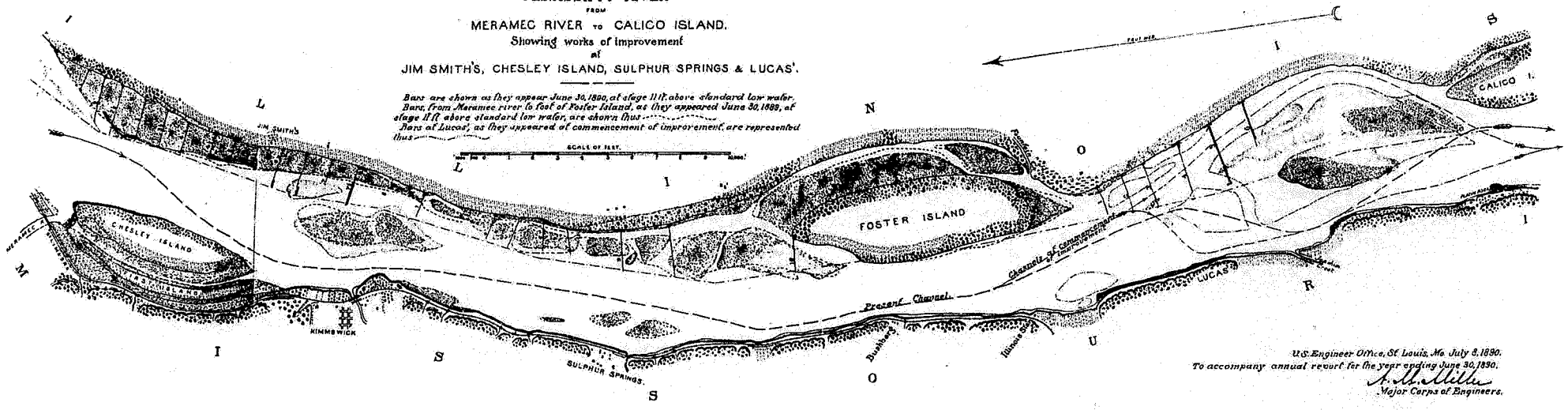
MERAMEC RIVER to CALICO ISLAND.

Showing works of improvement

at

JIM SMITH'S, CHESLEY ISLAND, SULPHUR SPRINGS & LUCAS'.

Bars are shown as they appear June 30, 1890, at stage 11 ft. above standard low water.
Bars, from Meramec river to foot of Foster Island, as they appeared June 30, 1888, at stage 11 ft. above standard low water, are shown thus .....
Bars at Lucas', as they appeared at commencement of improvement, are represented thus .....



U.S. Engineer Office, St. Louis, Mo. July 8, 1890.
To accompany annual report for the year ending June 30, 1890.

A. Mackenzie
Major Corps of Engineers.

Eng. 90

2934

1891

total of 16 months, removing 3,450 snags, cutting down 21,316 trees, removing 37 drift piles, and traveling a distance of 17,073 miles, thereby greatly benefiting navigation and commerce.

The boats were thoroughly overhauled and repaired and placed in good working order. An electric-light plant was also placed on the snag boat *Wright*. New boilers were ordered for the *Macomb*, but they had not been finished at the close of the fiscal year.

An annual appropriation having been made for carrying on this work, no further estimate is submitted.

Amount drawn under section 7, act of August 11, 1888	$92,500.00
June 30, 1891, amount expended during fiscal year	92,470.97
July 1, 1891, balance unexpended	29.03
July 1, 1891, amount available for fiscal year 1891–'92	100,000.00

(See Appendix Y 1.)

2. *Mississippi River between the Ohio and Illinois rivers.*—The original condition of the navigable channel of this portion of the Mississippi River, before the work of improvement was begun, was such that the natural depth at low water was in many places from 3½ to 4 feet, and the water was scattered by islands, which formed sloughs behind them, thus wasting the water available for low-water navigation.

The project adopted for improvement consists in closing these sloughs, and, by contraction works, the concentration of the water between banks 2,500 feet apart, the object being thereby to obtain a depth of 8 feet in the channel between St. Louis and Cairo, and 6 feet between Grafton and St. Louis at standard low water, or at a stage corresponding to a reading of 4 feet on the St. Louis gauge.

The amount expended up to the close of the fiscal year ending June 30, 1890, was $4,032,422.29. The condition of the improvement during the year past has been such that but little trouble was experienced between St. Louis and Lucas Crossing, a distance of 30 miles, as far as the work of improvement had been carried on June 30, 1891, and then only at extreme low water. For stages of water above 4 feet on the St. Louis gauge there has generally been a depth of at least 6 feet in the channel.

The amount expended during the fiscal year ending June 30, 1891, was $96,811.87, and was principally applied to the repair of plant. Owing to the late date at which the last river and harbor act was passed, it was impossible to get the plant in shape so as to do any work during the fall season and during the spring season, there being only one plant available, work was first done on the St. Louis Harbor, and after that was finished it was moved to St. Genevieve.

During the fiscal year work was carried on at the following localities:

Alton.—The work here consists of the extension of the present stone dike for a distance of 2,800 feet, the object being to prevent the formation of a bar in front of the landing at that place. The stage of water prevented any actual work being done, but a contract was entered into for the work, and it will be accomplished as soon as the stage of water will permit.

Rush Tower.—The project for work at this locality was adopted in 1890, and consisted in an extension of the general plan of improvement, so as to take in this locality. Work was not commenced until June 15, so that but little could be accomplished up to the close of the year. Two hurdles, Nos. 4 and 5 of this system, were located and partially built, and 600 feet of bank protection was placed in position. This bank protection was necessary, as the bank at one place had caved

so far as to be within 50 feet of the base of the levee, which protects the bottom lands from overflow. The amount expended at this locality was $3,926.06.

St. Genevieve.—The project for the improvement of this locality was adopted in 1890, and consisted in the construction of a series of hurdles on the Illinois side of the river, which were designed to prevent the channel leaving Little Rock, the landing for the town of St. Genevieve, and also to contract the river to a width of 2,500 feet. A system of four hurdles was contemplated, but owing to the fact that the bar at the foot of Turkey Island had moved so far downstream the upper hurdle was rendered unnecessary. Three hurdles, having a total length of 3,650 feet, were constructed and practically completed. The amount expended was $9,830.55.

Surveys.—A resurvey of the river between the foot of Horsetail Bar and Forest Home was made for the purpose of determining changes in the banks and channel of the river.

A reference to the plates accompanying the report of the officer in charge will give a graphic representation of the progress and effects of the works.

With the appropriation asked for fiscal year ending June 30, 1893, it is proposed to extend the general plan of improvement as far downstream as the funds available will permit.

The original estimated cost of this work, as revised in 1883, was $16,997,100, of which amount $4,529,600 has been appropriated.

July 1, 1890, balance unexpended		$97,177.71
Amount appropriated by act approved September 19, 1890		400,000.00
		497,177.71
June 30, 1891, amount expended during fiscal year		96,811.87
July 1, 1891, balance unexpended		400,365.84
July 1, 1891, outstanding liabilities	$20,720.86	
July 1, 1891, amount covered by uncompleted contracts	114,727.18	
		135,448.04
July 1, 1891, balance available		264,917.80

Amount (estimated) required for completion of existing project	12,467,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Y 2.)

3. *Harbor at St. Louis, Missouri.*—This work was originally part of the general improvement of the Mississippi River between the Illinois and Ohio rivers, and, as such, work was done at Sawyer Bend, Venice Dike, Arsenal Island, and Cahokia Chute Dam.

The river and harbor act of August 11, 1888, contained a provision for a special examination and survey of the harbor with a view to its improvement, and in a report made in December, 1888, it was stated that the St. Louis Harbor may be divided into two parts, the upper and the lower, the line of division being the Eads Bridge.

The lower portion, included between the river des Peres and the bridge, is 8 miles long, and the channel is good at all stages of water, the landings being easily accessible at all points.

The upper portion, included between the bridge and the northern limits of the city, is about 10 miles in length; of this portion the only part to be considered as at present included in the practical harbor is the reach between the bridge and the waterworks at Bissell Point, 3

Y 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND ILLINOIS RIVERS.

PROJECT.

The object of the improvement is to obtain a minimum depth at low water of 6 feet from the mouth of the Illinois River to St. Louis, a distance of 41 miles, and 8 feet from St. Louis to the mouth of the Ohio River, a distance of 191 miles, the natural depth at low water being in many cases from 3½ to 4 feet. The initial point of the work for the lower portion is St. Louis, the programme being to make the work continuous, working downstream from that city. Work at detached points has also been carried on under allotments specially made by law for the improvement of landings and the protection of local interests.

The plan of general improvement contemplates a reduction of the river to an approximate width of 2,500 feet below St. Louis, the natural width being in many cases from 1 to 1½ miles, and the protection of the alluvial banks from erosion. The methods employed are to build up new banks with the solid matter caught from the river itself by means of hurdles and revetment of the banks, both new and old, when necessary.

ORGANIZATION.

The organization of the engineering staff during the season was as follows:

A supervising engineer was assigned to the general supervision of all the works and of the supply depot. His office was in St. Louis and his duties were to advise and direct the resident engineers and to have especial charge of the supply of brush, stone, and piles, and of the towboat and barges engaged on the work.

The resident engineer was provided with quarters and an office at the work. His duties were to have immediate direction of the work of construction; to make such surveys and observations as might be required to keep the progress map, upon which all work was to be located, as fast as constructed; to keep the journal and other records of the work; to prepare pay rolls; to render quarterly property returns, semi-annual and annual reports to the officer in charge, forwarding them through the superintending engineer.

The superintending engineer was Mr. D. M. Currie. Resident engineers: At Ste. Genevieve, Mr. William S. Mitchell; at Rush Tower, and for the procurement of brush, Mr. C. D. Lamb.

WORK ACCOMPLISHED.

Owing to the lateness of the passage of the river and harbor bill, September 19, 1890, no work of construction was attempted during the fall, but contracts were entered into for the supply of material and the building of 13 model barges and extensive repairs to plant.

The amount appropriated by the river and harbor bill of 1890 was $400,000. Of this amount $50,000 was to be expended in the completion of the work at Alton and $50,000 for improving the river at St. Genevieve, in the State of Missouri.

The approved project for the expenditure of this amount contemplated work as follows:

For Alton Harbor (by law)	$50,000
For Ste. Genevieve (by law)	50,000
Repair and purchase of plant	40,000
Contingencies and repair of old work	15,000
Rush Tower, or new project	245,000
	400,000

ALTON.

The work at Alton consists of the extension of the present submergeable stone dike for a distance of 2,800 feet. The object of the work is to prevent the formation of a bar in front of the landing at Alton by directing the flow of water at low stages along the river front at that place. A contract was entered into for this work with Mr. H. S. Brown, of Quincy, Ill., under date of January 28, 1891. Owing to the lateness of the season and the danger of interference with the work by running ice, no work could be undertaken here during the fall or winter, and up to the 30th of June the stage of water has been too high to begin work; the contractor is prepared to go to work as soon as the stage of water will permit. The amount expended was $51.22.

RUSH TOWER.

Work was begun at the head of this section of the river about June 15, and is still in progress. Owing to the extreme depth of water found near the shore at the prevailing high stage, but little work could be accomplished in the way of hurdles. Two hurdles, Nos. 4 and 5, were located and partially built, and 600 feet of bank protection was placed in position. Work will be continued here as long as the season will permit.

The river here at high water has shown a tendency to make a crossing higher up than the channel of last year, and if this channel persists at low water a slight modification of the project here may be necessary.

The protection of the bank where work has been commenced, at a point about 1 mile below Calico Island, is necessary, as it has in one place caved so far as to be within 50 feet of the base of the levee which protects the bottom lands from overflow. The amount expended was $3,926.06.

ST. GENEVIEVE.

The work at this point consisted in the construction of a series of hurdles on the Illinois side of the river in order to prevent the channel leaving Little Rock, the landing for the town of St. Genevieve, and also to contract the river to a width of 2,500 feet.

Work was begun here on May 22, and continued up to the close of the fiscal year. A system of four hurdles was projected, but on an examination of the locality at the commencement of work it was found that the bar at the foot of Turkey Island had worked downstream so far as to render the construction of the upper hurdle unnecessary. Three hurdles, Nos. 2, 3, and 4, were constructed and practically completed; their lengths are, respectively, 1,500, 1,250, and 900 feet. Amount expended was $9,830.55.

PLATES.

Plate I is a general map of the river from the Merchants Bridge to Calico Island, and shows the location of the works, with the exception of the Alton dam. Plate II shows the work at St. Genevieve.

MATERIAL.

Brush and poles were obtained by hired labor, a royalty of 10 cents per cord being paid to owners of land where brush was cut.

Stone was obtained from the Grafton Quarry Company at 45 cents per cubic yard, loaded on Government barges at their quarry.

Rope, bolts, wire, spikes, nails, etc., were obtained by contract.

Piles were obtained by contract with Mr. John Cleary, of Chester, Ill., at prices varying from 6 to 8 cents per linear foot, according to length.

SUPPLY DEPOT.

The supply and subsistence department was under the immediate supervision of Mr. S. S. Van Norman. All supplies, except stone, brush, and piles, were delivered at the depot, foot of Arsenal street, St. Louis, and thence distributed on approved requisitions to the several works. In addition to this function of the depot it is a general repair shop and yard, where all repairs to plant not requiring dockage were made.

REPAIRS OF PLANT.

Necessary repairs were made to the steamer *Gen. Gillmore*, and to pile drivers, barges, quarter boats, and all floating plant. Two stern-wheel steam towboats for light work about the hurdles, moving barges, supplying piles, etc., were constructed. Fifteen pile drivers were taken out on the ways at Mound City, Ill., and their hulls completely repaired, new hulls were built for 4 pile drivers, and all other necessary repairs to leads, side braces, ladders, and machinery were made; 19 model barges were taken out on the ways and repaired and calked up to low-water draft line; new decks and other repairs were put on 11 barges. Twenty flats were built and provided with mattress ways; 51 skiffs and 19 yawls repaired.

For details of this and other work reference is made to reports of assistants forwarded herewith as part of this report.

The present value of the property remaining to be distributed on installation account is given in the following table:

Class of property.	Balance June 30, 1890	Debits.	Credits.	Balance June 30, 1891.
Barges, model and flats	$31,393.70	46,381.05	11,661.42	$66,113.33
Boat, machine shop	1,885.61	1,354.95	2,440.56	800.00
Boats, small	6,643.70	11,129.87	1,713.25	16,060.32
Drivers, pile	20,969.83	28,665.25	3,693.75	45,941.33
Shanties, portable	7,861.11	2,622.12	960.90	9,522.33
Steamer General Gillmore	11,815.45	13,076.04	13,384.70	11,506.79
Launches, steam	.....	6,513.62	.....	6,513.62
Tents	190.75	.....	.....	190.75
Supply depot	3,479.75	1,674.76	548.73	4,605.78
Tools and appliances	1,626.00	3,795.71	457.06	4,964.65
Boarding outfit	9,306.97	1,635.11	950.66	9,991.42
Office furniture	428.48	.....	42.85	385.63
Surveying instruments	471.61	32.25	47.16	456.70
Photographic apparatus	200.48	.....	.....	200.48
Total	96,273.44	116,880.78	35,901.04	177,253.18

GAUGES.

The gauges at Grafton and Gray's Point were read daily during the year. The readings are appended, marked A.

CONDITION OF THE RIVER.

The channel depths, as furnished by the Mississippi and Ohio Rivers Pilots' Association, for the year are appended, marked B. A full list of soundings could not be obtained, as the pilots' reports were not all preserved.

The river was open all winter and navigation was not interrupted by ice. This is the third successive winter with navigation uninterrupted.

The stage of water was lowest in December, January, and February, when it fell below standard low water; the highest stage was in June, when it reached a height of 19 feet above low water. The navigation of the river has been in a very good condition. The least depth met with in the portion of the river under improvement, a stretch of 30 miles from St. Louis, was 5 feet, found at Twin Hollows; this place soon deepened and a good channel of about 7 feet was maintained.

The locality, Twin Hollows, has been a difficult one for boats always; the works built here, however, for improving the channel have had a marked effect and the channel should be good and well defined this season. At Lucas', depths of 6 and 6½ feet were found in December, but soon scoured out to 7 and 8 feet. About the shoalest place in the river last season was at Perry's Towhead; this locality will be improved with the funds now available.

ESTIMATE.

The amount that can be profitably expended during the year ending June 30, 1893, is $1,000,000. It is proposed to expend this sum in carrying out the programme heretofore adopted—that is, to carry on the work of improvement continuously from St. Louis downstream, reclaiming land by building up new banks, thus reducing the river to an approximate width of 2,500 feet, alluvial banks to be protected from erosion. It is proposed to obtain by this means a channel of at least 8 feet at low water. The depth now is liable to become as small as 4 feet, or even less in some places, and less at every locality where the width is more than 2,500 feet.

This general statement of the proposed application of the appropriation is as specific as the nature of the case admits. The changeable character of the river renders it impracticable to give in advance the exact locality where works will be required.

The original estimated cost of this work, as revised in 1883, was $16,997,100; the aggregate amount appropriated to June 30, 1891, is $4,529,600; the amount expended to June 30, 1890, $4,032,422.

ABSTRACT OF APPROPRIATIONS MADE FOR THIS WORK.

By act of—		By act of—	
June 10, 1872	$125,000	June 14, 1880	$320,000
March 3, 1873	200,000	March 3, 1881	620,000
June 23, 1874	200,000	August 2, 1882	600,000
March 3, 1875	200,000	July 5, 1884	520,000
August 14, 1876	229,600	August 5, 1886	375,000
June 18, 1878	240,000	August 11, 1888	300,000
March 3, 1879	200,000	September 19, 1890	400,000

Money statement.

July 1, 1890, balance unexpended		$97,177.71
Amount appropriated by act approved September 19, 1890		400,000.00
		497,177.71
June 30, 1891, amount expended during fiscal year		96,811.87
July 1, 1891, balance unexpended		400,365.84
July 1, 1891, outstanding liabilities	$20,720.86	
July 1, 1891, amount covered by uncompleted contracts	114,727.18	
		135,448.04
July 1, 1891, balance available		264,917.80
Amount (estimated) required for completion of existing project		12,467,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1893		1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals received for furnishing lumber, opened October 3, 1890, by Maj. A. M. Miller, Corps of Engineers, St. Louis, Mo., under notice of 10 days, by circular letter dated September 23, 1890.

[Addresses of bidders: St. Louis, Mo.]

Kind.	Quantities.		F. Duff.	St. Louis Refrigerator and Wooden Gutter Company.	John J. Ganahl Lumber Company.	Eau Claire-St. Louis Lumber Company.	W. A. Bonsack.	Knapp, Stout & Co. Company.
	Pieces.	*Feet.*	*Per M.*	*Per M.*	*Per M.*	*Per M.*	*Per M.*	*Per M.*
White oak	476	26,272	*$23.00	$34.00	.....	.....	$35.00	.....
	40	2,317	*24.00	34.00	.....	.....	35.00	.....
	202	6,775	*25.00	34.00	.....	.....	35.00	.....
	3	240	*26.00	44.00	.....	.....	35.00	.....
	269	10,920	*28.00	44.00	.....	.....	45.00	.....
	90	600	*28.00	44.00	.....	.....	50.00	.....
	915	47,738	*29.00	44.00	.....	.....	45.00	.....
	104	8,403	*34.00	34.00	.....	.....	35.00	.....
	30	3,600	*34.00	44.00	.....	.....	45.00	.....
White pine	46	5,520	*30.50	36.00	35.00	.....	40.00	.....
	46	2,415	*28.50	34.00	35.00	.....	40.00	.....
	60	1,440	*20.50	25.00	30.00	.....	35.00	.....
	20	6,720	*32.50	36.00	40.00	.....	45.00	.....
	20	4,320	*31.50	36.00	37.50	.....	45.00	.....
	60	7,200	*25.00	29.00	32.50	.....	40.00	.....
	40	5,760	*26.00	36.00	37.50	.....	45.00	.....
	70	560	51.00	*30.00	37.50	45.00	.....	.....
	20	600	*51.00	55.00	55.00	.....	.....	.....
	34	776	*51.00	55.00	52.50	52.50	.....	.....
	20	320	51.00	55.00	52.50	*50.00	.....	.....
	20	467	.....	*60.00	65.00	.....	.....	.....
	20	400	*22.00	26.00	22.50	25.00	.....	.....
	500	15,000	22.50	25.00	*17.50	18.50	37.50	.....
	.....	7,000	18.00	17.50	16.00	*14.50	.....	.....
	.....	1,000	21.00	21.00	18.00	*16.50	.....	.....
	.....	28,000	15.50	16.00	15.00	*14.50	.....	.....
	.....	17,500	24.00	25.00	25.00	*18.00	.....	.....
	.....	16,800	40.00	37.50	36.00	.....	45.00	*$30.00
	.....	12,000	40.00	37.50	35.00	.....	45.00	*30.00
	.....	112,000	*40.00	†37.50	42.00	.....	45.00	.....
	.....	2,000	29.00	38.00	35.00	*17.50	.....	37.50
	.....	5,500	21.00	30.00	19.00	*19.00	.....	25.00
	.....	1,000	21.00	29.00	18.50	*17.50	.....	22.50
	100	6,667	.....	40.00	*37.50	.....	40.00	.....
Yellow pine	11	1,013	*28.50	40.00	30.00	35.00	.....	.....
	8	512	23.50	30.00	25.00	*22.50	.....	.....
	181	3,877	21.50	22.50	25.00	*20.00	.....	.....
	30	4,320	*27.50	40.00	30.00	35.00	.....	.....
	340	6,987	19.00	*15.00	16.00	16.00	.....	.....

*Awarded. Formal written contract entered into with F. Duff only; remainder purchased "under public notice of 10 days."

† Did not comply fully with specifications; the next lowest bid was therefore accepted.

Abstract of proposals received, in response to advertisement dated November 20, 1890, for furnishing piles, stone, manila and sisal rope, wire, nails, spikes, and screw bolts, opened December 20, 1890, by Maj. A. M. Miller, Corps of Engineers, St. Louis, Mo.

No.	Name and address of bidder.	Piles.					Stone, 30,000 cubic yards, per cubic yard.	Manila rope, 25,000 pounds, per pound.	Sisal rope, 7,000 pounds, per pound.	Wire, 50,000 pounds, per pound.	Nails, 18,000 pounds, per pound.	Spikes, 37,500 pounds, per pound.	Screw bolts, 30,000 per pound.
		5,500, 30 to 35 feet 178,750 feet per foot.	7,000, 36 to 40 feet, 266,000 feet, per foot.	4,000, 41 to 45 feet, 172,000 feet, per foot.	3,300, 46 to 50 feet, 158,400 feet, per foot.	1,200, 51 to 60 feet, 66,000 feet, per foot.							
		Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
1	Lawrence Evers, St. Charles, Mo	8	9	10	$10\frac{1}{2}$	11							
2	Daniel Kerwin, St. Louis, Mo												$2\frac{1}{2}$
3	Benj. F. Johnston, St. Elmo, Ill	8	$8\frac{1}{2}$	9	$9\frac{1}{2}$	10							
4	Mo. Lumber and Mining Co., Grandin, Mo.†	$8\frac{1}{4}$	$8\frac{1}{4}$	$9\frac{1}{4}$	$9\frac{1}{4}$	13							
5	John W. Reno, New Madrid, Mo.†	7	7	7	7	7							
6	Whitney Gilbreath, Ava, Ill., and James T. McClure, Wheatland, Ill	$6\frac{1}{2}$	7	$7\frac{1}{2}$	8	8							
7	Harry E. Coffin, Memphis, Tenn							$11\frac{43}{100}$	8	$3\frac{15}{100}$		*$2\frac{55}{100}$	$2\frac{58}{100}$
8	Ludlow-Saylor Wire Co., St. Louis, Mo.†									$3\frac{25}{100}$			
9	Grafton Quarry Co., St. Louis, Mo.‡						*45						
10	Leopold Methudy, St. Louis, Mo.†	$8\frac{7}{8}$	$8\frac{7}{8}$	$9\frac{5}{8}$	$10\frac{3}{8}$	$13\frac{3}{8}$							
11	Moran Bolt and Nut Manufacturing Co., St. Louis, Mo.†												$2\frac{55}{100}$
12	James J. Hawk, St. Louis, Mo							$12\frac{1}{2}$	$7\frac{9}{10}$	*$3\frac{03}{100}$			
13	Louis Grund & Martin Lorenz, St. Louis, Mo.‖†						64						
14	J. B. Morrell & Co., Brooklyn, N. Y.†										$2\frac{1}{20}$	$3\frac{1}{10}$	$3\frac{1}{4}$
15	Augustus W. Benedict, St. Louis, Mo							*$11\frac{13}{100}$	{*$7\frac{87}{100}$ *$7\frac{87}{100}$}				
16	Ward & Brady, St. Louis, Mo.†							$13\frac{3}{10}$	$8\frac{1}{4}$			$2\frac{9}{10}$	
17	Anchor Line Store, St. Louis, Mo							$12\frac{73}{100}$					$2\frac{58}{100}$
18	M. M. Buck & Co. St. Louis, Mo.†							13	$7\frac{1}{2}$	$3\frac{1}{10}$	*2	$2\frac{73}{100}$	$2\frac{55}{100}$
19	Berthold & Jennings, St. Louis, Mo.†	$8\frac{1}{4}$	$8\frac{1}{4}$	$8\frac{1}{4}$	$8\frac{1}{4}$	$8\frac{1}{4}$							
20	John Cleary, Chester, Ill.	*6	*$6\frac{1}{2}$	*7	*$7\frac{1}{2}$	*8							
21	St. Louis Bolt, Bridge and Forge Works, St. Louis, Mo												$2\frac{55}{100}$
22	H. L. Fox & Co., St. Louis, Mo									$3\frac{15}{100}$	$2\frac{03}{100}$	$2\frac{66}{100}$	*$2\frac{58}{100}$

* Contracts awarded. † Slight informalities in proposals. ‡ Quarry at Grafton, Ill.
‖ Quarry at St. Louis, Mo.

NOTE.—Formal written contracts entered into with all successful bidders, except M. M. Buck & Co. for nails.

Abstract of proposals received in response to advertisement dated November 20, 1890, for constructing an extension to dam at Alton, Ill., opened December 20, 1890, by Maj. A. M. Miller, Corps of Engineers, St. Louis, Mo.

No.	Name and address of bidder.	Piles, 80 sticks, 3,200 feet.			Brush, 33,000 cubic yards.		Stone, 16,500 cubic yards.		Amount of each proposal.
		Price driven to 14 feet depths, per foot.	Amount.	Price driven beyond 14 feet depths, per foot.	Per cubic yard.	Amount.	Per cubic yard.	Amount.	
1	James Short and John Gray, St. Charles, Mo	$0.28	$896	$0.35	$0.50	$16,500	$1.40	$23,100	$40,496
2	A. J. Whitney, Rock Island, Ill.	0.20	640	0.05	0.65	21,450	1.30	21,450	43,540
3	H. S. Brown, Quincy, Ill.*	0.10	230	0.05	0.65	21,450	1.00	16,500	38,270

*Contract awarded.

Abstract of proposals received in response to advertisement dated January 24, 1891, for building and delivering at Bushberg, Mo., thirteen model barges, opened February 24, 1891, by Maj. A. M. Miller, Corps of Engineers, St. Louis, Mo.

No.	Name and address of bidder.	Number proposed to furnish.	Price each.
1	Sanford S. Holbrook, Cincinnati, Ohio*	6	$3,750
2	Samuel W. Coffin, Cincinnati, Ohio†	13	3,795
3	St. Louis Sectional Dock Company, St. Louis, Mo	4	4,600
4	James Hill, Madison, Ind	13	4,150
5	J. J. Hammer & Son, St. Louis, Mo	5	4,880

*Contract awarded for 6. †Contract awarded for 7.

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

ST. LOUIS, MO., *June 30, 1891.*

MAJOR: I have the honor to submit the following report upon works for the improvement of Mississippi River, between the Illinois and Ohio rivers, including as part of it the reports of assistants in local charge, for the fiscal year ending June 30, 1891.

RUSH TOWER.

Work was begun at this locality about the middle of June, but on account of the excessive depths of water found near shore at the prevailing high stages of the river, but little progress had been made at the close of the fiscal year. Two hurdles, located as shown on the accompanying sketch, were started, and about 600 linear feet of mattress was placed in the protection of their shore ends, and a few piles were driven followed by the usual foundation mattress in each of the hurdles.

Reference is made to the report of Mr. C. D. Lamb for further details.

STE. GENEVIEVE.

This work embraced a series of hurdles below the foot of Turkey Island, located as shown on the accompanying tracing.

The bar below Turkey Island had extended down so far that Hurdle No. 1 of the project could not be built, when work was commenced in May, with the river at the stage of 14 feet above low water. Nos. 2, 3, and 4 were started in the order named and at the close of the year Nos. 2 and 3 were nearly finished and work was well advanced on No. 4.

Reference is made to the accompanying report of Mr. W. S. Mitchell for further details.

PROCURING MATERIAL.

Brush was procured by hired labor, the details of which are shown in the accompanying report of Mr. C. D. Lamb, superintendent in local charge.

Piles were procured by contract delivered at the work.

Stone for riprap was procured by contract delivered on Government barges at Grafton, Ill.

Bolts, nails, rope, spikes, wire, and other miscellaneous material were procured by contract when the quantities required were large, and by purchase when small, delivered at the supply depot in this city.

The towboat, pile drivers, barges, and other plant used in connection with the work are public property. The repairs and additions to it will be summarized under the head of plant.

PLANT.

The barges, pile-drivers, and nearly all the other plant received extensive repairs in which 19 barges and 15 pile-drivers were taken out on the ways at Mound City, Ill., and repaired below light-water line. The other repairs and renewals needed to restore the efficiency of the plant were made by hired labor and purchase of material, the details of which are shown in the accompanying report of Mr. S. S. Van Norman, superintendent of supplies.

At the close of the year 13 model barges were under process of construction by contract.

Very respectfully, your obedient servant,

D. M. CURRIE,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT.

ST. LOUIS, MO., *June 30, 1891.*

MAJOR: I have the honor to submit the following report of operations at Rush Tower during the fiscal year ending June 30, 1891:

The work to be done at Rush Tower includes the protection of the bank opposite "Kennett's" to prevent any further increase in the width of the chute east of the towhead and the beginning of hurdles, which form a part of the general project for improving this part of the river.

The construction of a shore mattress was begun on the 17th of June and at the close of the month 650 linear feet had been built and 575 linear feet placed, 75 linear feet being carried away by the strong current while partly sunk. This mattress was 80 feet wide, woven on way flat, and placed in three sections. It covered the bank from a 10-foot stage out to where the slope of the bank was very slight and has prevented all except a little surface scour.

The drift row of Hurdle No. 1, located 75 feet below the head of the shore mattress, was extended to a distance of 100 feet from shore, where the water was so deep that the piles on hand could not be used for the extension. A second hurdle was begun June 27, 900 feet below No. 1, and at the close of the year the drift row had been extended to a length of 100 feet.

The following table shows the amount of work done during the year, while its location is shown on the tracing accompanying the monthly report for June, 1891:

	Hurdle No. 1.	Hurdle No. 2.	Total.
Piles driven	19	15	34
Braces placed	11	11	22
Stringers placed	3	4	7
Shore mattress built:			
Linear feet			650
Square feet			52,000
Shore mattress placed:			
Linear feet			575
Square feet			46,000

Very respectfully, your obedient servant,

C. D. LAMB,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. W. S. MITCHELL, SUPERINTENDENT.

ST. LOUIS, MO., *June 30, 1891.*

MAJOR: I have the honor to submit the following report on the progress of the work for improving the Mississippi River at Ste. Genevieve, Mo., during the fiscal year ending June 30, 1891:

The project for this improvement of the river embraced a series of hurdles extending downstream from Turkey Island, and of such length as to reduce the width of the river to 2,500 feet next the Missouri shore. The upper hurdle was to be placed across the bar at the foot of the island, and the others were to follow at intervals of about 1,300 feet.

When work was begun, May 22, the stage of water, which was about 14 feet on the St. Louis gauge, did not admit driving piles on the upper line, Hurdle No. 1, within 750 feet from shore, and the bars extended so far below this line that Hurdle No. 2 seemed the upstream limit for the work, and here, also, a dry bar about 300 feet wide crossed the line 200 feet from shore, leaving a gap in the hurdle to be closed at higher water.

Pile-driving and mattress work were begun on both sides of this bar and were completed June 9. A rise of 7 feet in the 5 days preceding this date enabled the drivers to establish the line of drift piles across this gap, and the mattress was just started June 11, when the drift which had collected against the line and the rapid scour in the bottom carried out the piling. The drivers were put back in position and the line again started over the bar, but the few piles driven during the day were carried out at night. As the action of the jet-pump seemed to increase the scour and depths at the incomplete hurdle ends on either side of this gap it was thought best to move up 100 feet into shoaler water with less current and build a hurdle in front of the gap, connecting its ends with the main line. This work was completed June 29. During the rise drift had collected against the hurdle for 20 feet in width from the offset to the end of the line, 800 feet. A mattress was built over this and the whole was sunk to the bottom, forming a good protection for the base of this portion of the hurdle. The shore end of this line was protected with the usual stone and mattress revetment and the outer end by a T-head mattress. This hurdle is 1,500 feet in length and is complete, with the exception of wattling in those portions unprotected by drift.

Hurdle No. 3 was begun June 2 and was completed on the 29th. It is 1,350 feet long, and located 1,250 feet below No. 2, parallel and similar to the latter, with outer T-head mattress and revetted shore end. During its construction a portion of the drift row of piles about 250 feet from shore was crushed down against the hurdle row (the cross braces had not then been placed) by drift, piling, and a pile driver, which were carried out from No. 2 on June 11. The hurdle was not broken though, and after making a new drift row of the first hurdle row a new line of piles for wattling was driven behind it and protected by additional mattress. This hurdle is also complete with the exception of wattling.

Hurdle No. 4 was begun June 4, but on account of the rapid rise in the river and a scarcity of piles long enough for the work the drivers were withdrawn on the 6th and the line was not resumed until the 22d. None of the piling first placed was lost, and at the close of the month the drift row had been carried out 900 feet to the end of the line, and the mattress had been constructed 650 feet and sunk for 500 feet. This hurdle is parallel to the others and 1,400 feet below No. 3, and for 300 feet near shore crossed water, 30 to 35 feet in depth.

The season has been very favorable for the work, the river not having been at any time higher than 23 feet on the St. Louis gauge. The current at this stage has been very strong, but has brought with it a considerable deposit about the upper two hurdles.

The locations of the hurdles and soundings are shown on the chart accompanying the monthly report for June.

The force engaged on the work has averaged 10 pile drivers and 275 men, although it has been difficult to keep the full complement of men, owing to the demand for laborers in the country adjacent.

Very respectfully, your obedient servant,

WM. S. MITCHELL,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

MISSISSIPPI RIVER
FROM
BISSELL'S POINT TO CALICO ISLAND.
Showing location of works of improvement.
June 30, 1891.

SCALE.

Bars are shown as they appear June 30, 1891, at stage 11 ft. above standard low water.

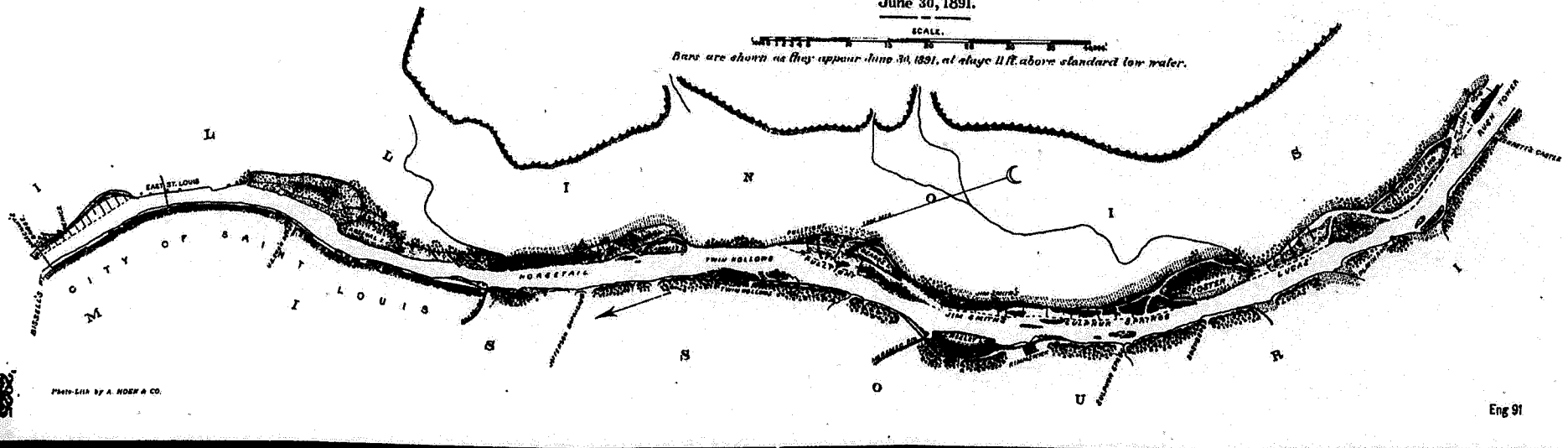


Photo-Lith by A. HOEN & CO.

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Plate 2.

MISSISSIPPI RIVER

FROM

TURKEY ISLAND TO STE. GENEVIEVE.

Showing works of improvement.

Bars are shown as they appear July 1891, at stage 11 ft. above standard low water.
Bars as they appeared in Aug. 1889, at stage 6.40 ft. above standard low water shown thus

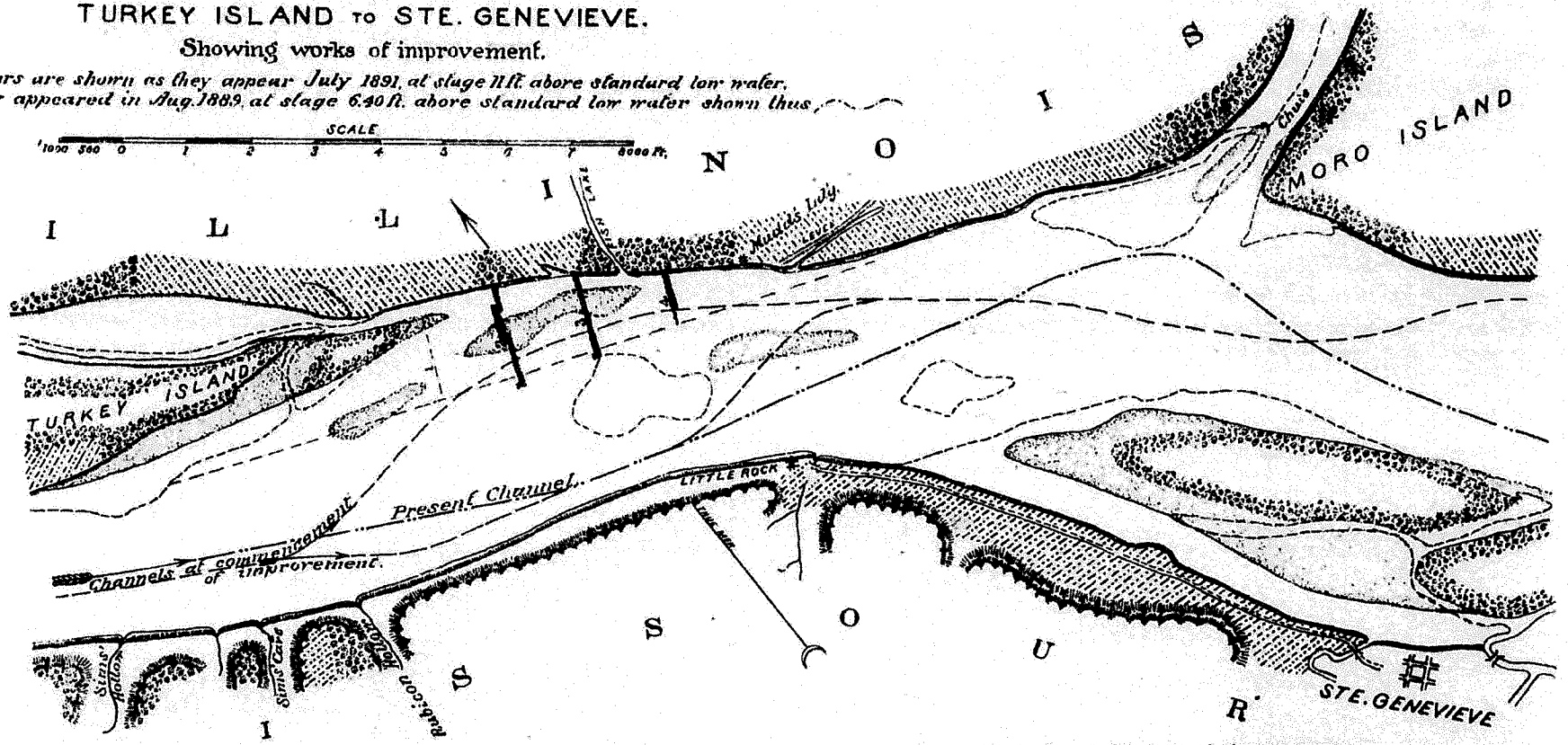

Photo-Lith by A. HOEN & CO.

U.S. Engineer Office, St. Louis, Mo. July 17, 1891.
To accompany annual report for the year ending June 30, 1891.

A. Mackenzie Miller
Major Corps of Engineers, U.S.A.

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