

An examination of this stream was made several years ago by Mr. A. H. Blaisdell, assistant engineer, under the direction of Lieut. Col. W. F. Reynolds, Corps of Engineers, the report upon which will be found in that of the Chief of Engineers for 1872, page 386, *et seq.* From these reports it will be seen that the obstructions to the safe navigation of the stream consist of snags and overhanging trees, and also a series of shoals, these latter being more numerous in the upper part of the river above Perryville. These shoals are of varying width, from 25 to 100 feet, and the depth over them at low-water varies from 1 inch to 2 feet. There is not sufficient water, therefore, to justify any attempt to improve the navigability of the river over these shoals at the lowest stage. When there is a moderate stage of water in the Arkansas, the back-water causes quite good navigation in the Fourche La Févé. Under these circumstances it only seems advisable to attempt the removal of the snags and like obstructions from the stream. For this purpose Mr. Harrison estimates that it will require the sum of \$23,034.50.

If this improvement be made, it will, no doubt, be of great benefit to that section of the country which has to depend upon the river to transport its products to market.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,  
Captain of Engineers.

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

REPORT OF MR. ZEPH HARRISON, ASSISTANT ENGINEER.

MEMPHIS, TENN., January 6, 1879.

SIR: I have the honor to present herewith my report on the recent examination of Fourche La Févé River, Arkansas.

The Fourche La Févé River takes its rise in the extreme westerly part of the State of Arkansas. The general course of its flow is in an easterly direction, emptying into the Arkansas River about 40 miles above Little Rock.

In accordance with your instructions, I left Memphis on the 9th of December and proceeded to Little Rock. Here I hired two men, laid in the necessary stores for camping out, and then started up the Arkansas River on the Aunt Sallie, a small steamer which Capt. Harvey Lewis kindly loaned us. At the mouth of the Fourche La Févé our party obtained a large, light-running skiff and rowed up to Perryville, 40 miles.

Having learned that the distance overland from this place to Snyder's Landing was only one-quarter of that by water, I secured a team and transported our boat and effects to that point, 10 miles by land, 45 by water, from Perryville, and made the forks of the river, some 6 miles above, the initial point of my reconnaissance.

We then gradually descended the river, taking the sinuosities of the stream, soundings, number of snags, &c. At the outstart the weather resembled the spring season, the water was entirely open all the way to the mouth, and there was every prospect of pushing on our work without delays of any kind, but the sky suddenly clouded over, the weather grew colder, and we saw nothing but cold rain, snow, sleet, and ice. In the long stretches of ice that we encountered, one man, in the bow of the boat, was constantly engaged in breaking the ice, which was from one to 4 inches in thickness, and making a channel for the boat. The oars could not be used, except in sculling, and very slow progress was made.

Near the shoals there was always open water, but we generally grounded and were compelled to wade and pull the boat over. The river at low-water has a uniform width of from 100 to 125 feet, and an average depth of 10 feet. The shoals have from 1 inch to 2 feet of water over them, generally about 2 inches in extreme low-water. The bottom of the river is mud overlying clay; the shoals have a boulder or gravel bottom over solid rock, which contains a small amount of iron. A list of the shoals forming the chief obstructions, and which are more numerous in the upper part of the river, is given below.

The river has a fall from the forks to Perryville, a distance of 45 miles, of 30 feet, or

8 inches to the mile. The next 40 miles, to the mouth of the stream, has a fall of only 5 feet, or  $1\frac{1}{4}$  inches to the mile. I know this from the high-water marks of the back-water from the Arkansas River.

Table of shoals from Smyer's Landing to the mouth of the river.

Names of shoals.	Distance from Smyer's Landing.	Length of shoals.	Width of river at low water.	Channel at low-water.		Fall.	Kinds of bottom.
				Width.	Depth.		
Snyder's.....	Miles. 4	Feet. 1,600	Feet. 75	Feet. 25	Inches. 4	Feet. 5	Boulder.
Back.....	8	400	50	35	4	4	Gravel.
McElrath.....	14	300	50	35	3	3	Slate.
Telford.....	15	300	75	30	3	2	Do.
Rock Creek.....	25	1,000	75	50	3	6	Boulder.
Haleom.....	27	300	100	50	3	2	Slate.
Harrison.....	28	200	100	100	2	0.5	Rock.
Lunsford.....	41	100	100	125	1	0.8	Do.
Alford.....	48	500	100	100	2	1	Rock.*
May.....	53	800	100	100	2	1	Boulder.*
Pine Point.....	54	100	100	100	2	0.8	Boulder.
Red Ferry.....	77	150	25	30	6	2	Rock.
Moccasin Bluffs.....	80	100	100	100	24	0.2	Gravel.

\*Large rock to be excavated.

The river has a high, steep, non-caving bank on one side, and a gentle declivity on the other nearly the whole distance. Near Rock Creek there is a bluff about 150 feet high, extending nearly a mile along the south bank of the river. The May Mountains, Pine Point Mountains, and the Moccasin Bluffs border the river below Perryville.

The bottom-lands are very extensive on both sides of the river, and where cultivated are proven to be very rich, yielding as high as seventy-five bushels of corn to the acre with very primitive culture; they are subject to the annual overflows, being covered in some places to a depth of fifteen feet headwater or backwater from the Arkansas River.

The valley of the Fourche La Févé is one of the most extensive in the State. It reaches to the Choctaw Nation, and the stream throughout its entire length is thickly wooded with a very superior growth of hickory, oak, black walnut, ash, cypress, sycamore, gum, beech, holly, birch, box-elder, pecan, and other woods of great commercial value. The adjacent ridges likewise abound in a thick growth of yellow pine. The valley varies in width from one to eight miles; the soil is rich; cotton of the better grades is produced, and wheat, corn, and other cereals can be raised in abundance. For all these products there is no adequate outlet except through the proposed navigability of the river in question. At present, the farmers of this region, in order to reach a market at all, are compelled to cross the Petit Jean and Magazine Mountains, which practically operate as a barrier against the full development of the country. Notwithstanding all these difficulties, about 5,000,000 feet of lumber, 1,000 bales of cotton, and a large quantity of grain, furs, poultry, tallow, beeswax, and other articles have been taken this season from the valley of the Fourche la Févé. There are likewise mines of lead, iron, and other metals in the valley that could be profitably worked if this improvement should be made.

Perryville is the only town on this river; it has a population of about four hundred and does a flourishing local business.

My estimate of the cost of the proposed improvement of the Fourche la Févé River, from its junction with the Arkansas River to Snyder's Landing, a distance of 85 miles, embraces the removal of 3,410 snags from the bed of the river; the clearing of the timber from the banks to a width of 30 feet on each side, amounting to 618.18 acres; and rock excavation at the Alford and May Shoals, 200 cubic yards.

As no snagboat of the usual dimensions can ascend this stream, it will be necessary to construct a flatboat, fitted with crane and steam-power, and provided with the regular outfit of tools and rigging for pulling out the snags and cutting trees. This can be built at the head of the proposed improvement, as there is a saw-mill and other facilities already there.



The monthly expenditures for running such a boat would be—

Engineer in charge.....	\$150 00
Mate.....	100 00
Twenty laborers, at \$40 per month.....	800 00
Cook and assistant.....	60 00
Subsistence of 24 men, at 50 cents per day.....	360 00
Total.....	1,470 00

ESTIMATED COST OF PROPOSED IMPROVEMENT OF FOURCHE LA FEVÉ RIVER FROM SNYDER'S LANDING TO MOUTH OF RIVER.

Craneboat.....	\$5,000 00
Flatboat for quarters, &c.....	800 00
Rigging and tools, \$400; 25 per cent. for repairs.....	500 00
Removing snags and cutting trees, nine months' work, at \$1,470.....	13,230 00
Rock excavation, 200 cubic yards, at \$2.50.....	500 00
	20,030 00
Contingencies, 15 per cent.....	3,004 50
Total.....	23,034 50

Total length of stream to be improved so as to make it navigable about six months in the year, 85 miles.

Very respectfully submitted.

ZEPH HARRISON,  
Civil Engineer.

Maj. W. H. H. BENYAURD,  
Corps of Engineers, U. S. A.

L 15.

IMPROVEMENT OF THE MISSISSIPPI RIVER AND HARBOR AT VICKSBURG, MISSISSIPPI.

The Board of Engineers convened to consider the subject of the above improvement recommended that the first step in the work should be towards the protection of the Delta Point, with a view of stopping the caving of the bank and keeping the main channel of the river from receding farther from the city.

To this end preparations were made in July last to carry on the work, but before the actual commencement the yellow fever made its appearance in Vicksburg, and as the force, though located at Delta Landing, had communication with that city, the local authorities of Madison Parish caused the force to be withdrawn, and accordingly work was suspended until the abatement of the fever.

Operations were again resumed in November, and it was hoped that a sufficient amount of work would be accomplished to fully test the efficacy of the willow-mattress plan to the protection of the bank. Great difficulty was experienced from the outset. First, the weather turned very cold, and running ice greatly interfered with the work, and afterwards a rising river brought down quantities of drift, which proved some obstacle to the prosecution of the work. Seeing no prospect of continuing with any success until low-water should occur, I gave orders to suspend work for the season.

On May 25, 1879, the water having fallen sufficiently to admit of some work being done, preparations were again made to continue the improvement, which is now in course of execution and will be carried on to the extent of the available funds appropriated. For the details of

the construction, &c., I refer to the report of Mr. T. G. Dabney, assistant engineer, appended.

Since the recommendation of the Board of Engineers was made, great changes have taken place in the vicinity of Vicksburg. The channel has receded some 1,600 feet farther from the city, and the general filling up in the inner harbor amounts to an average of about 15 feet. During the last season alone the Delta Point has receded some 600 feet, and a filling up of the harbor has taken place of from 5 to 6 feet. The caving of the flats below the town has also continued. A reference to the map herewith will readily show the extent of these changes.

The time which has unavoidably elapsed and the changes which have been made will necessarily produce a modification of the second and third plans recommended by the Board of Engineers for the inner harbor; for the present, work will be confined to the attempt to hold the Delta Point. The success attending the execution of the same character of work at Memphis gives reasonable grounds for success at Delta.

As regards the inner harbor, I do not see that anything can be done there at present within *reasonable* limits of expenses to keep that harbor open from below. The upper channel, leading around to the upper part of town, is at present the only available channel at low-water.

The former appropriations for this work are as follows:

By act approved June 18, 1878.....	\$84,000
By act approved March 3, 1879.....	50,000

COMMERCIAL STATISTICS.

During the year ending September 1, 1878, 175,387 bales of cotton were received and shipped, of which 30,016 were shipped by rail and the balance by river. To this should be added a proportionate amount of general merchandise.

The Vicksburg, Shreveport and Texas Railroad brought to Delta during the same year about 35,000 bales of cotton, and all return freight and merchandise for that part of Louisiana passes through Vicksburg Harbor.

All the steamboats passing to and from New Orleans to points farther north land at this place, and are more or less affected by the improvement of the harbor.

For port of entry and amount of revenue collected, see Report on Removing Obstructions, &c., from Red River, Louisiana.

Money statement.

July 1, 1878, amount available.....	\$84,000 00
Amount appropriated by act approved March 3, 1879.....	50,000 00
	\$134,000 00.
July 1, 1879, amount expended during fiscal year.....	38,241 75
July 1, 1879, amount available.....	95,758 25
Amount (estimated) required for completion of existing project.....	120,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1881.....	60,000 00

REPORT OF MR. THOMAS G. DABNEY, ASSISTANT ENGINEER.

VICKSBURG, Miss., June 30, 1879.

MAJOR: I have the honor to submit the following report in connection with the work of improving the harbor of Vicksburg for the fiscal year just ended. The operations now in progress to arrest the caving along the upper side of the Delta peninsula is the only part of the general plan for reclaiming this harbor which has



as yet received particular attention, being the only part of the work provided for by an appropriation.

This work consists of a revetment of willow mattresses, applied to the caving bank from a point about 2,200 feet below the head of "Grant's Canal," opposite the town of Delta, La., down to the point of the peninsula known as Delta Point. The object of the mattress application is to arrest the caving of this bank, which has been going on rapidly since the "cut-off" occurred in April, 1876, and primarily to prevent the farther recession of the channel of the river from the harbor of Vicksburg.

The plan had in view and recommended by the Board of Engineers, of which General J. H. Simpson was president, which considered this subject, contemplated other work after the revetment above referred to should be accomplished, with the object of excluding the inflow of mud and sand by which the harbor has been shoaled up, and excavating to sufficient depth in the new deposit for harbor purposes.

This work was to be accomplished by a system of "bar dikes" and a dredge-boat. The time which has unavoidably elapsed without any considerable progress being made in the first part of this work since the recommendations of the board above referred to were made has very materially increased the cost which would be necessary to perform the second part, to wit, the bar dikes and dredging. During this time the channel has receded about 1,600 feet further from the town, and the additional filling in the harbor amounts to a general average of more than 15 feet.

While it is true that the additional deposit would diminish the height of the dike structure, yet its length would be proportionately increased, and the additional amount of dredging made necessary is very considerable. At present about one-half of the area of the old channel in front of the town has reached an elevation of 20 feet above low-water, a portion being 21 feet above, and the lowest point being 10 feet above.

The filling throughout the harbor during the past season amounts to a general average of between 5 and 6 feet. Delta Point has caved off a distance of 600 feet to this date during the past year.

As stated above, the primary object of revetting the caving bank along the Delta peninsula had reference to the subsequent work in the harbor contemplated. But there are also other and very important ends to be gained by securing this bank against the erosive action of the current, which intimately affect the commercial interests of Vicksburg, as well as grave evils to be removed and prevented which threaten, and indeed now oppress, these interests. The steamboat and railroad, and in fact all other commercial interests in the town, notably the sawmills, are now at great loss in view of the uncertainty in which the location of the future landing is involved.

The most important steamboat line, the Saint Louis and Vicksburg Anchor Line, has a large and costly elevator building, the usefulness of which is destroyed during a considerable part of the year, and its period of usefulness is being rapidly diminished from year to year, as the shoaling of the harbor increases.

It cannot be determined when it will be safe to erect another building; hence this line is subjected to great loss and inconvenience during the low-water season.

The wharf-boat, where all the general steamboat business is transacted, was compelled to abandon its usual position in front of the town more than a month ago. It has been shifting from one point to another, constructing new landings at much expense and great inconvenience, there being no place at present where a permanent location can be made. The Vicksburg and Meridian Railroad is suffering from the same cause. Much of its city track is rendered useless during part of the year, and it can only approach a landing with the certainty of having to take up and relocate the track. The 3 sawmills, which do a very large business, and the large cotton compress are in the same predicament. They all either now are or soon will be without water in their fronts at low-water, and it cannot be determined where to relocate them. And so it is that every interest depending upon or pertaining to the river traffic is in a condition of suspense and uncertainty, which entails vast inconvenience, trouble, and loss on the business community.

While it may be held as certain that this evil will in time cure itself by the cessation of the caving by natural processes, yet the period is extremely indefinite. It is only certain that some years must elapse before the caving would cease unaided by artificial application, during which time these interests must continue to suffer, probably in an increasing ratio, and all city property to depreciate in value. And even after the caving should apparently have come to an end, there would still be a reasonable feeling of insecurity, since the Mississippi River is so capricious in these matters, lest the caving should recommence to the still further destruction of property values by throwing the landing further down. It is moreover a matter of importance that the future landing should be fixed as short a distance below town as practicable, which depends directly upon fixing the position of Delta Point as early as possible.

There is another consideration to be noticed in this connection of even greater importance to the town of Vicksburg. The Vicksburg, Shreveport and Texas Railroad, which now terminates at Delta, and is operated as far as Monroe, on the Ouachita River, has for some years past been involved in a state of litigation. This has been

finally settled by the United States Supreme Court, and the road ordered to be sold. The original bondholders have formed a strong company with the intention of purchasing the road, and are now perfecting arrangements for its early completion to Shreveport, Louisiana, where it will connect with the railroad system of Texas, which will at an early day extend west to the Pacific Ocean. There is already eastern connection from here to all points on the Atlantic seaboard. This will then become a very important line of traffic, and the point of crossing on the Mississippi River, one of corresponding importance, being practically on the transcontinental line of railroad, along the 32d parallel. I have been informed among the engineers who will probably control the location of this crossing, what appears to be sufficiently obvious, that if the Delta Point is made secure against the destructive action of the river, there will be located the terminus of that road, and a line of ferry will convey the trains directly across to the Vicksburg landing; but that, in the present condition of instability which characterizes the Point, they will find it necessary to seek a more secure crossing elsewhere, and no other point could be suggested as at all eligible within 10 miles of Vicksburg, below, from which connection would be made eastward without approaching Vicksburg. The disastrous effects of such arrangements to Vicksburg need not be commented on.

It is greatly to be deplored that the yellow-fever epidemic of last year practically destroyed the season for the purposes in view. This entailed not only the loss of much ground in connection with this work, but also the expenditure of a considerable sum of money with small returns.

It is true that much of this expenditure was for property, buildings and structures necessary to the work and which are still serviceable. It is, however, also true that a good deal was spent in futile efforts to reclaim at least part of the season after the epidemic ceased, against obstacles too great to be successfully encountered, such of which, however, as it arose appeared to be temporary in its nature, and I was therefore encouraged to persevere, appreciating the great importance of accomplishing something, if possible, before the approaching season of caving arrived. Moreover, the experience gained at that time is of great value now, such experience being rendered necessary from the novel character of the work, my want of previous acquaintance with its mode of operation, and the peculiar features of difficulty which present themselves in this particular field.

I was placed by you in charge of this work in July, 1878. I began at once making the necessary preliminary investigations, and in August set to work a force of men grading a portion of the bank above the caving locality for the erection of "ways" upon which to construct willow mattresses, and to building quarters for the men. About the middle of August the alarm of yellow fever spread abroad and rigid sanitary measures were adopted by communities. On the 27th of August I was required by the local authorities to withdraw my workmen from that locality, they apprehending the introduction of yellow fever from that source, and I received an intimation that unless I did so at once force would be resorted to to compel my withdrawal. I accordingly withdrew, secured the property which I had accumulated, and discontinued for the time being all efforts to prosecute the work.

When the epidemic had almost subsided, about the 10th of November, I resumed work; had buildings erected to quarter the men, &c., graded a portion of the bank, and constructed a set of mattress "ways" thereon, procured boats for the transportation of willows, and other purposes, and chartered the light-draught steamboat Yellowstone for towing.

When the "ways" were nearly completed a sudden rise in the river partially destroyed them by washing away the newly-graded surface of the bank. I was thereby admonished that the ways in that position were very insecure, but was relieved of this perplexity by the ingenuity of Capt. J. H. Gunning, superintendent of the mattress work, who suggested the construction of floating "ways." This was accordingly done, under his supervision. Two long coal-boats were procured, each being 165 feet long. These were cut down nearly to the gunnels, placed alongside of each other and securely bolted together with 1-inch bolts through the gunnels. Upon this foundation was erected a set of "ways," composed generally of 4 by 6 cypress lumber, the *skids* or *runs* being capped with 4 by 4 heart pine, the cypress being too soft to withstand the wear. These "runs" were placed parallel to each other, about 6 feet apart, extending across the two boats transverse to their length, supported by posts set 3 to 4 feet apart and well braced. The upper ends of the "runs" are elevated 8 feet above the gunnel, the lower ends resting on the outside gunnel. (See sketch previously forwarded.) This gives an inclination of 8 in 50, which experience has shown to be too slight, as the difficulty of starting the mattress off is too great. Another set made subsequently has an inclination of 10 in 50, which gives better results. The "runs" also rest 6 inches above the outside gunnel and extend 6 feet beyond, so that the ends touch the water when loaded with a mattress, which can then be slid off without any jar. I have found it expedient to strengthen these outer ends by bolting on a 4 by 6 stringer on the under side to prevent their being broken off by contact with boats, &c. These "ways" will accommodate a mattress 175 by 50 feet.



The mode of constructing adopted for the mattresses is this: longitudinal stringers are laid on the "ways" 8 feet apart, composed of willow or cottonwood poles spliced together, the maximum size being 5 to 6 inches at the butts. Upon these are placed transversely, 8 feet apart, other poles, somewhat smaller, with occasionally a larger sized one. At the intersections are inserted pins of swamp hickory  $1\frac{1}{2}$  and 1 inch diameter and 3 feet long. The willow brush is then laid on in four or five layers transverse to each other to a thickness of two feet. The upper ends of the pins are received into poles placed transverse to the length of the mattress, the longitudinal ones being dispensed with on top. Additional strength is given by wiring with number 12 wire at the intersections of the poles, the wire passing through the mattress and secured to the top and bottom frames. The pins are made without heads, being driven through a steel plate, having orifices of proper size. They are secured by wedging and nailing. The mattress when ready for sinking is moored in its position alongside a flat composed of the bottom of a long coal-boat, floored over, from which stone is distributed over its surface. This operation is assisted by using several small stone flats, 30 by 12 feet, which are moved from place to place around the mattress. The mattress is securely anchored to points above by long lines attached by trip-toggles, by which they can be released after it has been sunk. The mattresses are so arranged that when sunk the shore end rests on the bottom about low-water mark, while the other extends outwards down the slope so as to cover the sand strata underlying the bank.

Having completed preparations for work, the first mattress, 50 by 150 feet, was made and launched on the last day of December, 1878. It was successfully sunk at a point above the actual caving. Two others were made and sunk during the next three days just below the first. These were not in a position to test their efficacy, as the bank was not expected to cave at that place, but they were intended to secure well the upper end of the work. At this juncture there came on a very severe freeze, the river being also filled with floating ice, and it became necessary to suspend operations. About the middle of January, or a little later, the river having become clear of ice, work was resumed. In the mean time, finding the steamer Yellowstone then in my employment, very expensive, I dismissed her and chartered the tug Belle Darlington, in New Orleans.

At this time the river began to rise, and attained a height of  $35\frac{1}{2}$  feet on the gauge, and furthermore was filled with an extraordinary quantity of drift-wood, which greatly incommoded my work. I was impressed with the belief, however, that in the absence of the drift-wood I could operate successfully with that stage of water, having sunk the first mattress with  $28\frac{1}{2}$  feet on the gauge, and I was exceedingly reluctant to give up the season without testing the matter.

Two more mattresses were made and launched, and preparations made for sinking them, when they were unfortunately both lost by the awkward handling of the tug, which became involved with the Delta wharf-boat, and could not release herself until the mattresses were carried below Delta Point. All efforts to tow back one of them proved unavailing. After this the mattresses were secured by lines to the bank before being launched. I should have stated that one of the mattresses lost was tied up to the bank and broke away by an accumulation of drift-wood while the tug was engaged with the other. A sixth mattress was launched and placed in position for sinking, a favorable wind having blown the drift-wood off shore. The position selected for this mattress was a point where a strong current impinged directly upon the bank, my object being to fully test the feasibility of carrying on the work successfully with that stage of water, and I also deemed that this point needed protection more than any other. Before getting this one down, a lull in the wind brought the drift-wood back upon it, and the sinking was a failure.

An attempt was made to sink a seventh at the same point, with only partial success, 40 to 50 feet of the outer end breaking off and going away. At this juncture, January 31, seeing that I was spending money with small chances of benefit, I caused the work to be entirely suspended, retaining only men enough to take care of the property.

About May 25, the river having fallen to a low stage, preparations were again set on foot for a resumption of the work. In order to have facilities for pushing the work with rapidity, a second set of "ways" was constructed, and 6 large coal-boats procured for the conveyance of willows. These have been overhauled, repaired, and calked, as well as the boats in use last season, which have suffered some in the mean time.

Within a few days past a force has been set to work getting willows, and another making mattresses. The number of men is as yet small, there being 40 men at the willow camp and 30 at the mattress works. One mattress, 50 by 175 feet, has been constructed and launched, and another is on the "ways." It is deemed advisable to let them remain in the water a few days before sinking in order to accumulate silt, which will diminish the weight of ballast required to sink them. The working force will be increased as speedily as possible, when the work is expected to go forward rapidly, unless interrupted by high water.

Much was gained by last season's experience, both in constructing and handling the mattresses, and I have strong hopes that with a favorable season the entire extent

of the caving bank will be covered and secured against the further encroachment of the river.

I submit herewith a map showing present condition of harbor and the changes that have occurred during the past year.

Upon reading the report of Maj. Chas. R. Suter, Corps of Engineers, for the fiscal year ending June 30, 1878, published in the report of the Chief of Engineers, 1878, regarding the improvement of the Missouri River at Nebraska City (Appendix M, pp. 653, *et. seq.*), I am confirmed in the belief that it would be wise and judicious, if the appropriation shall justify it, to apply the same process there described by Mr. Max Boehmer, assistant engineer, to wit, the "Brownlow Weed" brush dike, as an auxiliary to the mattress application; the dike to be located above the upper end of the revetment with a view to covering the bank below as far down as possible, and also with the hope of developing successfully an aggressive policy towards the current of the river.

Major Suter appears to have been eminently successful in his efforts in that direction, under conditions not entirely dissimilar to those prevailing here.

I have the honor to be, very respectfully, your obedient servant,

THOMAS G. DABNEY,  
Assistant Engineer.

Maj. W. H. H. BENYAURD,  
Corps of Engineers, U. S. A.

## L 16.

IMPROVEMENT OF THE MISSISSIPPI RIVER AND HARBOR AT MEMPHIS,  
TENNESSEE.

The work as inaugurated has for its object the protection and maintenance of the harbor of Memphis, and the protection of the landing along the city front from erosion by the Mississippi River.

The plan adopted for the purpose consists in applying to the caving bank a protection of brush in the form of mattresses loaded with stone, extending from a short distance above low-water out to the greatest depth. As the depth of water along the front varies from 55 to 75 feet, the length of the protection extending out into the stream varies from 150 to 200 feet.

Active operations were commenced in July last upon the protection of the bank below the mouth of Wolf River. We had proceeded with the work but a short distance when the yellow fever broke out, which caused a suspension of work until cool weather. Work was again commenced, but high-water and ice interfered and we had to suspend for the season. In May, 1879, we again resumed and at present the work is in course of execution.

Up to the end of the present year about 700 feet of bank protection had been applied. So far it has been successful in attaining the object in view. It withstood successfully the flood of last winter, and while the bank above and below caved very badly, where the mattress protection was adopted not a foot caved in.

During the coming season it is proposed to continue the work upon the bank protection, and if nothing interferes I hope to have the work extended so as to cover half the city front, and the utility of the plan fully demonstrated.

For the details of the operations I refer to the report of Mr. Joseph Burney, assistant engineer, herewith.

## COMMERCIAL STATISTICS.

Merchandise and produce sold for twelve months ending September 1, 1878, \$70,000,000. Of this amount \$22,000,000 was cotton, home produce and home manufacture, \$3,500,000.



About 70,000 bales of cotton were shipped by river to Liverpool, England, and 70,000 bales sent North on steamboats. 400,000 bales of cotton were received.

Number of steamboats landing at Memphis during twelve months, 2,500.

The collections at custom-house in Memphis, Tenn., during the year ending June 30, 1879, are as follows:

Duties on imports.....	\$10,308 09
Hospital dues (marine).....	2,183 82
Steamboat inspection.....	1,575 35
Licenses to engineers, pilots, &c.....	2,955 00
Total.....	17,022 26

The former appropriations are as follows:

By act approved June 18, 1878.....	\$46,000
By act approved March 3, 1879.....	37,000

#### Money statement.

July 1, 1878, amount available.....	\$46,000 00
Amount appropriated by act approved March 3, 1879.....	37,000 00
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July 1, 1879, amount expended during fiscal year.....	\$83,000 00
	36,174 61
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July 1, 1879, amount available.....	46,825 39
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Amount (estimated) required for completion of existing project.....	87,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1881.....	30,000 00

#### REPORT OF MR. JOSEPH BURNEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,  
Memphis, Tenn., June 30, 1879.

MAJOR: I have the honor to submit the following report of operations in connection with the improvement of the Mississippi River and Harbor at Memphis, Tenn.

In July, 1878, I received your instructions to take charge of the work, and active operations commenced July 15, 1878. A location for the ways for construction of mattresses, workshops, &c., was chosen at the mouth of Wolf River, being nearly in the center of river front to be protected. Mattress ways 200 feet long by 75 feet wide were constructed as follows: the bank was cut to an angle of 40 degrees and stringers 6 by 4 inches with rounded tops were placed 5 feet apart down the bank; these were supported by posts 6 by 4 feet, placed 5 feet apart and sunk into the ground 4 feet. The stringers were secured by  $\frac{3}{4}$ -inch drift-bolts driven into the posts.

A tool-house, warehouse, and open shed were erected for the workmen, and about  $\frac{1}{2}$  acres of ground fenced in with a picket fence.

The necessary tugboats, flatboats, and barges were hired and purchased, and the stone was obtained from Messrs. J. & H. Loudon, & Co., of Memphis, delivered on barges, at the works, for \$2.45 per cubic yard.

A willow-brush party of 50 men was organized and sent 30 miles up the river to obtain brush and poles, and a working force of about 75 men was engaged at the works on Wolf River.

The first mattress, 125 by 50 by 3 feet, was constructed and launched August 8, 1878, and the second one August 15. About this time the yellow fever began to spread in Memphis, and a regular stampede occurred. Out of the 75 men employed only 5 reported for duty on the 16th of August, when you ordered the work to be suspended. The brush party was called in, and after sinking the two mattresses and placing all the property in good order properly secured, the workmen were discharged. It was difficult to obtain a responsible watchman, the works being situated in the most unhealthy part of the city. Mr. Smith, foreman of the brush party, volunteered his services, and I am pleased to state that he survived the fever and kept the property in good order.

The work was again commenced November 7, 1878, when I made inquiries as to the deaths from yellow fever among our workmen, and found that out of 125 men 42 had died, and in one family employed by us, of father and four sons, only one son remained alive.

Work was continued in building and sinking mattresses, but was much interrupted by high water and drift logs, and on the 21st of December we were compelled to suspend operations until December 30, when we only made slow progress on account of floating ice, and on the 25th of January, 1879, the river became entirely covered, and the work was ordered to be suspended until the following low-water season. Work

was again commenced May 20, 1879, and at this date everything is in active operation and making steady and satisfactory progress.

There are two portions of the river front to be protected. The first is above Wolf River, a short distance above the city of Memphis. The second is from Wolf River down to the Elevator. The latter is immediately in front of Memphis, where all the business connected with the river is done. Being the most important, you ordered this portion of the river bank to be protected first. Your instructions were that the mattress work should extend on the bank from 10 feet above low-water to the bed of the river—this makes about 150 feet of bank to protect—and also that the upper bank should be graded to a uniform slope. The river bank is very irregular in its formation, and we have to construct the mattresses to suit the bank, so that they vary in size from 150 by 50 by 3 feet to 100 by 40 by 2.9 feet.

In the construction of the mattresses various designs have been adopted in order to find out the most suitable. At first four layers of willow poles were used. The first layer at the bottom of the mattress was formed by placing willow poles 4 feet apart, and recrossed by poles 4 feet apart and securely pinned together by  $\frac{3}{4}$ -inch oak pins. On this frame was placed a layer of willows, then a frame-work of poles forming 12-foot squares, then another layer of brush, and again a frame-work of poles in 12-foot squares, then another layer of brush with a frame-work of poles forming 4-foot squares. These were required to retain the stone in position. The whole mattress was secured by oak pins and bound together by No. 12 annealed wire. After the first three mattresses were constructed only three layers of poles were used, and from experiments it is now considered best to use only two frame-works of poles, one on the top and the other on the bottom, the center being entirely of willow brush. Every 8 feet apart the top and bottom frame-work is secured by 1-inch oak pins, and bound with No. 12 wire. This makes a pliable and strong mattress.

There is no difficulty in constructing and launching the mattresses; the great difficulty is in sinking them. One end must rest on the bank and the other in water varying in depth from 60 to 80 feet, with a current to contend with of 4 miles per hour. We have constructed and sunk 23 mattresses and only lost portions of three. The first loss we had was when the yellow fever broke out, not having sufficient men to sink the mattress, and the other two were on mattresses 150 feet long, when they began to sink in deep water about 30 feet of the end would break off and be lost, while the balance sunk in its proper position. In sinking great care has to be taken to ballast the mattresses evenly or they readily break to pieces. Up to date we have used no guide piles in sinking, but the mattresses have been placed in position and secured by lines made fast to the river bank. At times, when we have secured the mattress in position, before any ballast was placed on it, the current would strike the upper side and carry it down 20 or 30 feet under water, when the current would strike the under side and bring it to the surface again. At present we have a good working force, composed chiefly of raftsmen, and they are meeting with good success.

In 1878 the work was carried on under unusual and unexpected difficulties, viz: yellow fever, high water, and ice, and having to suspend three times, breaking up our working force, so that by the time the men would begin to understand their duties they had to be discharged.

In 1878 we protected 290 feet of river bank where the worst caving was going on. The high water covered all the mattress work, and did not fall until May, 1879, when a careful examination was made with the following result: about 800 feet above the bank protected it had caved 150 feet, gradually growing less to the mattress work, where no caving occurred. Along the 290 feet of bank protected not a single foot of caving had taken place, but below the mattress work it had caved a little, and 400 feet below the caving was 52 feet (see map accompanying report), thus showing that while the work had been prosecuted under great difficulties the mattress work had done all that the most sanguine could expect.

The work has been inspected by a number of experienced and interested persons, and, as far as it has progressed, and up to the present time, they pronounce it a perfect success.

In 1878 we protected 290 linear feet of bank, and in 1879 to June 30, 385, making a total length of 675 feet.

At the present date the working party is thoroughly organized, and the work progressing steadily and satisfactorily.

We have purchased for the work one new pile-driver, 3 flatboats to carry stone, and 1 brush-flat.

The tugboats, brush, barges, &c., required, are hired by the day.

During the fiscal year ending June 30, 1879, 23 mattresses have been sunk, using 2,394 cords of willow brush, 379 cords of willow and cottonwood poles, and 1,350 cubic yards of stone.

I have the honor to remain, very respectfully,

JOSEPH BURNEY.

Maj. W. H. H. BENYAURD,  
Corps of Engineers, U. S. A.