

Amount drawn under section 7, act of August 11, 1888.....	\$81, 809. 61
June 30, 1905, amount expended during fiscal year.....	81, 809. 61
July 1, 1905, amount available for fiscal year 1905-6.....	<u>100, 000. 00</u>

(See Appendix X 1.)

2. *Mississippi River between Ohio and Missouri rivers.*—In its original condition the navigable channel of this section of the Mississippi River had a natural depth in many places of only $3\frac{1}{2}$ to 4 feet at low water. The channels were divided by islands which formed sloughs and secondary channels, or chutes, through which a great deal of the volume of the flow was diverted, to the detriment of navigation.

The first effort to improve this condition was begun in 1872 and was continued for a number of years as appropriations were made, the works consisting of dikes and dams of brush and stone erected with a view to confining the low-water volume to a single channel and of revetments to hold and preserve the banks where necessary or advisable to do so.

The project followed up to the present time has been that adopted in 1881, approved by letter of the Chief of Engineers dated March 31, 1881, contemplating the confinement of the flow of the river to a single channel having an approximate width below St. Louis of 2,500 feet at bank-full stage, the natural width in many cases being a mile or more at mean high water; this result to be sought by closing sloughs and secondary channels and by building out new banks where the natural width is excessive, using for this purpose permeable dikes or hurdles of piling that collect and hold the solid matter that is carried in suspension or rolled on the bottom of the river; the banks, both new and old, to be revetted or otherwise protected where necessary to secure permanency, and, pending the completion of the permanent improvement, the low-water channel to be improved each season by the use of dredges and other temporary expedients. The cost of the work remaining to be done was estimated in 1903 at \$20,000,000, with annual expenses of \$400,000 for maintenance. It was hoped that the cost might be reduced by increasing the amount of dredging.^a

The river and harbor act of March 3, 1905, appears to contemplate, however, a permanent departure from the project of 1881, above outlined, in devoting more attention to dredging and less to works of permanent improvement, and authorized the construction of two new hydraulic dredges of the most approved type.

The object of the improvement is to obtain and maintain a minimum depth, at standard low water, of 6 feet from the mouth of the Missouri to St. Louis, and of 8 feet from St. Louis to the mouth of the Ohio.

The total amount expended to June 30, 1905, was \$11,345,893.15, exclusive of \$180,000 allotted by acts to projects for improvement between the Illinois and Missouri rivers, including Alton Harbor.

The amount expended during the fiscal year ending June 30, 1905, includes \$62,600.68 expended for temporary expedients. The total amount thus far expended for temporary channel improvements is \$693,437.02, much of which has been for plant that is now on hand and available for future work. The approximate value of this plant is \$168,695.49.

^a See Annual Report of the Chief of Engineers for 1904, p. 2144 et seq.

The result of the expenditure of this amount has been the partial improvement of the entire extent of the river from St. Louis to Cairo.

Theoretically this improvement should have some influence on freight rates, but an accurate estimation of such effect has been impracticable during recent years.

During the past year there was maintained a channel depth of 8 feet, except for very short periods in the low-water season, when at several bars 7 feet was noted, until a dredge could be moved to the locality. These obstructions were promptly removed.

The river at St. Louis reached a high-water stage of 24.4 feet above standard low water on July 12, 1904, and a low-water stage of 4.3 feet below standard low water on January 1, 1905.

With the present appliances and such others as may be developed for the temporary improvement of low-water channels, it is expected that a navigable depth of about 8 feet can be maintained between St. Louis and Cairo during all stages while the river is open to navigation.

The local officer states that \$400,000 should be provided annually for the purpose of maintaining an 8-foot channel by dredging, with such auxiliary works as temporary diking, bank protection, and occasional hurdle building.

The sundry civil act approved March 3, 1905, appropriated \$650,000 for continuing the improvement of the Mississippi River from the mouth of the Ohio to and including the mouth of the Missouri River.

Recapitulation of commercial statistics.

	1901.	1902.	1903.	1904.
Receipts and shipments at St. Louis.....	<i>Tons.</i> 672,076	<i>Tons.</i> 641,182	<i>Tons.</i> 552,617	<i>Tons.</i> 377,635
Transferred by ferries at St. Louis.....	5,880,592	5,731,635	6,328,154	6,060,109
Shipped from landings between St. Louis and Cairo	10,978	17,179	43,807	43,672
Total	6,563,646	6,389,996	6,924,538	6,501,716

July 1, 1904, balance unexpended.....	\$940,313.93
July 1, 1905, miscellaneous receipts.....	2,557.77
Amount appropriated by sundry civil act approved March 3, 1905..	650,000.00

1,601,871.70

June 30, 1905, amount expended during fiscal year:

For works of improvement.....	\$503,203.20
For maintenance of improvement.....	213,299.29

716,502.49

July 1, 1905, balance unexpended.....	885,369.21
July 1, 1905, outstanding liabilities.....	28,302.17

July 1, 1905, balance available.....	*857,067.04
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* Distributed under subheadings as follows:

For protection of bank of Missouri side and to deepen and straighten channel at Wittenberg, Mo., act of March 3, 1899..	\$10,000.00
For from mouth of Ohio River to mouth of Missouri River:	

Act of April 28, 1904.....	212,356.48
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Act of March 3, 1905.....	634,710.56
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857,067.04

July 1, 1905, amount covered by uncompleted contracts..... \$48,880.00
 Amount (estimated) required for completion of existing project... 18,251,654.55
 (See Appendix X 2.)

OPERATING SNAG BOATS AND DREDGE BOATS ON UPPER MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND ST. PAUL, MINNESOTA, OF HARBOR AT MOLINE, ILLINOIS, AND OF LA CROSSE HARBOR, WISCONSIN; OPERATING AND CARE OF GALENA RIVER IMPROVEMENT, ILLINOIS, AND OF ILLINOIS AND MISSISSIPPI CANAL AROUND THE LOWER RAPIDS OF ROCK RIVER, AT MILAN, ILLINOIS.

This district was in the charge of Maj. Jas. L. Lusk, Corps of Engineers, until July 18, 1904; in the temporary charge of Maj. C. S. Riché, Corps of Engineers, from July 18 to October 18, 1904; in the charge of Major Lusk from October 18, 1904, until April 1, 1905, and of Major Riché since April 1, 1905. Division engineer, Col. O. H. Ernst, Corps of Engineers, until April 5, 1905, and Lieut. Col. W. H. Bixby, Corps of Engineers, since that date.

1. *Operating snag boats and dredge boats on upper Mississippi River.*—By the river and harbor act of August 11, 1888, provision was made for securing the uninterrupted work of snag boats and dredge boats on the upper Mississippi River under a permanent appropriation, the sum so expended not to exceed \$25,000 annually.

During the past fiscal year the snag boat *Colonel A. Mackenzie* was employed from July 1 to November 4, 1904, and from May 12 to June 30, 1905, in removing snags and other obstructions and otherwise assisting interests of navigation between Minneapolis and the mouth of Missouri River.

Dredge *Vulcan* was employed for a few days in September, 1904, in removing sand deposits at Fulton steamboat landing, and for about six weeks in September and October, 1904, in dredging a channel through the bar above Keithsburg bridge.

Dredge *Phœnix* in September and October, 1904, was engaged in removing obstructions at various points between Keokuk and Turners Landing, and in May and June, 1905, in removing deposits from the Keokuk steamboat landing.

The total amount expended for snag-boat service to June 30, 1905, was \$949,584.

The total quantity of freight transported on the upper Mississippi River during the calendar year 1904 was about 4,534,539 tons, and the ton-miles 943,951,451; in 1903, 4,545,129 tons, and 979,951,901 ton-miles.

The amount expended during the fiscal year ending June 30, 1905, was \$25,000.

(See Appendix Y 1.)

2. *Mississippi River between Missouri River and St. Paul, Minn.*—Under this head is carried on the improvement of through navigation and also such special harbor or levee work as is provided for by Congress. Systematic work was begun in 1878, and such good results have been secured as to demonstrate that with a continuance of

TABLE No. 1.—Summary of expenses for operating U. S. snag boats H. G. Wright and J. N. Macomb—Continued.

Application.	1904.	1905.			
	December.	January.	February.	March.	April.
Office expenses.....	\$810.07	\$10.60	\$784.30	22.40	.....
Expenses of snag boat H. G. Wright:					
Crew.....	2,125.00	2,100.00	2,118.00	2,118.50	\$1,465.00
Outfit.....					709.53
Fuel.....	852.50	814.95	495.90	404.55	407.00
Subsistence.....	393.82	497.18	463.07	507.11	74.47
Supplies.....					632.56
Repairs.....	70.97				1,228.00
Miscellaneous.....		4.90			.....
Expenses of snag boat J. N. Macomb:					
Crew.....	2,077.16	2,081.00	2,018.00	1,797.31	1,358.50
Outfit.....					636.83
Fuel.....	1,051.25	924.65	768.54	640.50	204.00
Subsistence.....	531.10	188.91	793.23	150.66	225.77
Supplies.....			32.01		262.83
Repairs.....			116.46		831.28
Total.....	7,917.87	6,622.15	7,590.17	5,621.06	8,095.77

Application.	1905.		
	May.	June.	Total.
Office expenses.....	\$782.50		\$3,338.98
Expenses of snag boat H. G. Wright:			
Crew.....	1,454.00	\$1,465.00	22,823.43
Outfit.....	337.46	43.32	1,217.92
Fuel.....	130.40	118.80	6,977.10
Subsistence.....	230.85	252.79	4,519.33
Supplies.....	184.71	22.84	835.84
Repairs.....	398.14	380.55	2,597.02
Miscellaneous.....			4.90
Expenses of snag boat J. N. Macomb:			
Crew.....	1,398.83	1,480.00	22,024.33
Outfit.....	213.30	22.50	949.15
Fuel.....	158.00	158.00	9,340.72
Subsistence.....	272.61	237.55	4,797.57
Supplies.....	63.03		357.87
Repairs.....	464.80	505.56	2,025.45
Total.....	6,538.62	4,676.91	81,822.81

X 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

PROJECT OF 1881, REVISED IN 1883.

A concise statement of the project for and history of this work will be found in the Annual Report of the Chief of Engineers for 1905, page 424, as well as on page 2631 of the Report of the Chief of Engineers, United States Army, for 1900.

Reference should be made to the Report of the Chief of Engineers, United States Army, for 1894, pages 1577 et seq., for information relating to the development of the various forms of construction and for a résumé of the various types employed between 1872 and 1894, and to the reports of the Chief of Engineers, United States Army, for 1895 (p. 2059), 1896 (p. 1717), 1897 (p. 2012), 1898 (p. 1698), 1900 (p. 2632), and 1901 (p. 2169) for minor details as to forms of construction.

Since the adoption of this project work has been done substantially according to the methods referred to above at the following localities: Mouth Missouri River, Sawyer Bend, St. Louis Harbor, Cahokia Chute, Arsenal Island, Horsetail Bar, Carroll Island, Twin Hollows, Pulltight, Beards Island, Chesley Island, Jim Smiths, Sulphur Springs, Foster Island, Lucas, Cornice Island, Osborne Field, Rush Tower, Michaels Landing, Fish Bend, Danby Landing, Rush Towhead, Penitentiary Point, Turkey Island, Ste. Genevieve, Kaskaskia Island, Chester, Crain Island, Liberty Island, Liberty Bend, Seventy-six Landing, Willard, Hamburg, Devil Island, Minton Point, Cape Girardeau, Commerce Island, Burnham Island, Powers Island, Goose Island, Buffalo Island, Dogtooth Bend, Greenleaf Bend, Hurricane Field, Greenfield Bend, and vicinity of Cairo.

During the fiscal year ending June 30, 1905, work for the permanent improvement of the river has been carried on, as hereinafter described in the report of Mr. Wm. S. Mitchell, principal assistant engineer.

PERMANENT IMPROVEMENT.

The project adopted for the improvement of the Mississippi River between the mouths of the Ohio and Missouri rivers was approved by the Chief of Engineers, United States Army, March 31, 1881. The estimate of the cost, as revised in 1883, was \$16,397,500. The project was modified by the river and harbor act of June 3, 1896, to permit the construction and operation of dredges. It was again modified to some extent in 1903 by the Board of Engineers for Rivers and Harbors in report dated November 12, 1903, the dredging authorization of which was adopted by Congress in the river and harbor act of March 3, 1905. Under the modification of 1903, hurdle work for the contraction of the channel and revetments to prevent erosion of the banks may be considered auxiliary and subsidiary to dredging, which, if found advantageous, is authorized as the chief means of maintaining the channel.

By the report of 1903 the cost is increased \$20,000,000 in addition to expenditures already made, provided the projects already in force be adhered to throughout. The cash expenditures to December 31, 1903, are considered as approximately the cost of the work up to the date of the report of the Board. They were \$10,476,654.53. The total estimated cost as last revised is therefore \$30,476,654.53.

The total amount appropriated to June 30, 1905, was \$12,404,999.98. Of this amount \$180,000 was allotted by acts and projects for improvement between the Illinois and Missouri rivers, including Alton Harbor, leaving a balance of \$12,224,999.98 to be applied to the project for the general improvement between the mouths of the Ohio and Missouri rivers. The balance of the last revised estimate not appropriated June 30, 1905, is therefore \$18,251,654.55.

The amount expended to June 30, 1904, was \$10,629,390.66. The amount expended during the fiscal year was \$716,502.49, of which \$716,496.27 was paid by voucher and \$6.22 was paid by the Auditor for the War Department. The total amount expended to date is therefore \$11,345,893.15.

The balance unexpended June 30, 1905, of the amount appropriated, is \$879,106.83, to which must be added \$6,262.38, received from mis-

cellaneous sources, making a total balance of \$885,369.21, exclusive of outstanding liabilities and amount covered by contract.

Under the project submitted May 10, 1905, by direction of the Chief of Engineers, United States Army, which was approved May 17, 1905, the balance available June 30, 1905, of the appropriation of April 28, 1904, which is \$163,476.48, after deducting outstanding liabilities and amount covered by contract, will be applied during the fiscal year ending June 30, 1906, to emergency works of improvement, care of plant, temporary expedients in dredging, and for engineering and contingencies.

Under the same project the balance available June 30, 1905, of the appropriation of \$650,000 in the sundry civil act of March 3, 1905, will be applied during the fiscal year ending June 30, 1906, to alterations of dredges on hand, building two dredges, dredging, and administration and contingent expenses, any balance therefrom to be held in reserve. The balance available is \$634,710.56, the sum of \$15,289.44 having been paid during the last fiscal year for work done in Sawyer Bend by the Chicago, Burlington and Quincy Railway Company, in 1900 and 1901, as required by the act.

The river and harbor act approved June 3, 1896, provided:

That any balance of former appropriations now available, and the money hereby appropriated and authorized to be expended for the said section of the river between the mouth of the Missouri River and the mouth of the Ohio River, or so much thereof as may be necessary, shall be expended in the construction of suitable dredge boats, portable jetties, and other suitable appliances, and in the maintenance and operation of the same, with the view to ultimately obtaining and maintaining a navigable channel from St. Louis to Cairo not less than two hundred and fifty feet in width and nine feet in depth at all periods of the year, except when navigation of the river is closed by ice.

In the \$11,345,893.15 above mentioned is included all amounts expended to June 30, 1905, for dredge plants, portable jetties, and appliances for temporary improvement of the channel and for operating the same, altogether \$693,437.02. Of this, \$62,600.68 was expended during the fiscal year for dredging. The approximate value of this plant at the beginning of the fiscal year was \$181,136.33. Its present approximate value is \$168,695.49.

The river and harbor act approved March 3, 1905, relating to this section of the river reads as follows:

Improving Mississippi River from the mouth of the Ohio River to and including the mouth of the Missouri River: The Secretary of War may prosecute the improvement of the said section of the Mississippi River by dredging, as set forth in the report of the Board of Engineers for Rivers and Harbors, submitted November twelfth, nineteen hundred and three; and the said Secretary of War may purchase or cause to be constructed two dredges, to be employed with those now in use in said section for the purpose of dredging; and the said Secretary may, in his discretion, expend a portion of the balance now remaining on hand to the credit of said improvement for the completion of works already under way or for the construction of other works which will be useful in promoting the navigation of said section of the river; and such balance as remains on hand, together with the amount authorized to be expended in pursuance of contracts to be made, is hereby made available for the purpose set forth in this item.

The sundry civil act approved March 3, 1905, making appropriation for this section of the river, reads as follows:

Improving Mississippi River from mouth of Ohio River to Minneapolis, Minnesota: For continuing improvement, in completion of contract authorization, from the mouth of the Ohio River to the mouth of the Missouri River, six hundred and fifty thousand dollars. * * *

It would appear from the wording of the above items that it is the intention of Congress to materially modify the approved project of 1881 by devoting attention principally to dredging in obtaining and maintaining a navigable channel between St. Louis and Cairo.

By direction of the Chief of Engineers, United States Army, dated May 23, 1903, being the first indorsement on copy of request of the Board of Engineers for Rivers and Harbors, for reports bearing upon the desirability of continuing or modifying certain projects for river and harbor improvement, I submitted to the Board, under date of May 29, 1903, the following report:

THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
Washington Barracks, Washington, D. C.

Sirs: In answer to first indorsement on a letter, dated May 21, 1903, from the Board of Engineers for Rivers and Harbors to the Chief of Engineers, relating to a discussion of the present method of improving the Mississippi River between the mouths of the Ohio and Missouri rivers, with a view to ascertaining whether by dredging or otherwise a suitable channel can not be established and maintained at less expense than in accordance with the existing project, I have the honor to report as follows:

At the time the present project was adopted hydraulic dredges of great capacity had not come into general use, and the idea of keeping a channel open by means of the small scoop or clam-shell dredges then in vogue was correctly deemed absurd. Since that time, however, dredging has been practically revolutionized, and it has been found practicable to maintain a good low-water channel in the Mississippi River below Cairo by the use of hydraulic dredges of large capacity alone.

The existing project for this district contemplates securing a minimum depth at low water of 8 feet by giving the channel "a uniform width of 2,500 feet by means of pile-work hurdles built out from the bank to the necessary extent, and also by means of such temporary expedients as movable dikes—for the purpose of concentrating the flow over bars—and dredging. The banks are to be made permanent where subject to scour by revetment of mattress and broken stone.

This has worked very well in many parts of the river where the width was excessive, as, for example, Horsetail bar, but at other places floods have had a tendency to excavate a channel behind the hurdles, proving that even with the moderate floods that have occurred since the improvement was begun the method is not altogether certain in its results. If we could be sure that the river would maintain the moderate rise and fall that has prevailed in recent years, the method might be worthy of continuance, but it must be kept in mind that the Mississippi River is at times of excessive flood, flowing, as it does, in a soft alluvial bed of 5 miles in width from the Missouri to Commerce, and of much greater width thence to Cairo, virtually uncontrollable by any human agency. In other words, the hurdles put in and maintained at great expense may, in any great flood, be in considerable part wiped out or disarranged and the river assume new courses. This has been its history for thousands of years. It has wandered from one side to the other of its alluvial bed, and it is my opinion that it will so continue in spite of any efforts of man to control it within practical limits of expense.

Viewing the subject from a purely economical standpoint it should be stated that about \$9,000,000 has already been expended on the present project, and 6 feet of low-water navigation is all that has been accomplished. To complete the project about \$13,000,000 will be required. Owing to the fact that every flood shifts the bottom and forms new bars, I am of the opinion that dredging will have to be resorted to extensively even after the hurdles are completed. The project when completed will have cost, therefore, some \$22,000,000. This money is worth at least 4 per cent to the revenue producers, or, say, \$880,000 per year. This represents what the funds would be worth in wealth and prosperity producing power if not locked up in the present project of improvement. In addition, however, \$150,000 will, as may be inferred from the above statement, have to be appropriated every year for dredging after its completion and \$150,000 will be necessary every year for

"The original report stated "low channel" by error, the 2,500 feet referring to the bank-full stage.

repairs, making a permanent fund of \$300,000 which Congress will be compelled to appropriate every year after the expenditure of the \$22,000,000. Adding this to the \$880,000 interest on the latter amount we have \$1,180,000, which is what the improvement will be actually costing the country every year after its completion.

Viewing the matter in this light, it has frequently occurred to me to question the propriety of continuing much further along the present lines. It is my present belief that for \$500,000 appropriated every year by Congress—which is only \$200,000 more than what would be necessary in any event after the completion of the improvement—it would be possible to excavate a channel of 8 or even 9 feet every low water, by means of temporary dikes and dredging, as well as torevet the banks sufficiently to materially diminish the burden of bar-making sediment and incidentally tend to preserve the farming lands and levees and also to put in an occasional hurdle if found expedient.

These figures are only tentative and it may cost somewhat more to annually obtain and maintain the desired channel depths, but I believe that enough has been stated to show that an annual appropriation of even \$600,000 would be cheaper in the end than to complete the present project at an expense of \$22,000,000.

Very respectfully, your obedient servant,

THOS. L. CASEY,
Major, Corps of Engineers.

The decline of commerce on the river, as shown by statistical tables, constitutes a really serious economical consideration in planning future works of improvement in this district. It is stated by those residents of St. Louis who appear to be still actively interested in the navigation of the river, that if a depth of 8 feet can be assured to them without chance of failure from other cause than ice and can be guaranteed for a number of years in the future, the commerce of the river will revive. In view of this statement, I am of the opinion that the importance of the subject warrants the experiment and would recommend that Congress grant a continuous appropriation of \$400,000 a year for ten years for this purpose. If, after the expiration of this period, wherein it can be demonstrated that 8 feet or more has been continually maintained, there appears to be no material increase in the commerce of the river, it is but just to the taxpayers of the country that this particular improvement be suspended indefinitely. I would further recommend that in obtaining and maintaining this depth of 8 feet or more throughout the year of open navigation, the War Department be given considerable latitude by Congress as to the exact method to be employed to attain this result. There is no doubt that it can be readily accomplished by dredging, but not unless the banks are properly held by revetments at many points and other auxiliary works, such as temporary diking and occasional hurdle building, be permitted.

The amount necessary to complete the project of 1881, including expenditures already made, as given in my letter above, is considerably less than the \$30,000,000 or more estimated by the Board of Engineers for Rivers and Harbors in 1903, as stated above. It is probable that the latter estimate falls nearer the truth and renders the principal argument of my report still more patent. In view of this a further expenditure of \$4,000,000, as recommended above, in striving to rehabilitate the commerce of the river, enabling us, as it undoubtedly will, to form a definite estimate of the propriety of continuing further appropriations, seems therefore to be conservative and the fairest course to pursue toward the commercial interests of this section.

The expenditure of public funds for the mere and solitary purpose of keeping railroad freight rates within satisfactory bounds, is, in my

opinion, not a legitimate solution of that problem; first, because these funds are granted by the General Government for the purpose of bettering the facilities for actual navigation, there being many of the chief ports of entry of the country where they could be expended to much better advantage, and, secondly, because there are other ways of reducing the freight charges of the railroads, such as State or national legislation or, better still, actual competition between the railroads themselves, the latter being increasingly evident among the lines paralleling the Mississippi River. A State legislature, if honest and unapproachable, has as much power and capacity to regulate the prices to be paid per ton for freight handled by the railroads within its boundaries as it has to regulate passenger rates.

The appended report of Mr. Wm. S. Mitchell, principal assistant engineer, gives full details of operations at the various localities in this district on construction work, temporary expedients, dredging, repair and care of plant, procuring materials, operations of quarry, gauges, and discharge observations, during the past fiscal year.

Money statement.

July 1, 1904, balance unexpended	\$949,313.98
July 1, 1905, miscellaneous receipts.....	2,557.77
Amount appropriated by sundry civil act approved March 3, 1905	650,000.00
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	1,601,871.70
June 30, 1905, amount expended during fiscal year:	
For works of improvement.....	\$503,203.20
For maintenance of improvement.....	213,299.29
	<hr/>
	716,502.49
July 1, 1905, balance unexpended	885,369.21
July 1, 1905, outstanding liabilities.....	28,302.17
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July 1, 1905, balance available	^a 857,067.04
	<hr/>
July 1, 1905, amount covered by uncompleted contracts.....	48,880.00
	<hr/>
Amount (estimated) required for completion of existing project	18,251,654.55
	<hr/>
{ Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905:	
For works of improvement.....	\$200,000.00
For maintenance of improvement	200,000.00
	<hr/>
	400,000.00
{ Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	
^a Distributed under subheadings as follows:	
For protection of bank on Missouri side and to deepen and straighten channel at Wittenberg, Mo., act of March 3, 1899	10,000.00
For from mouth of Ohio River to mouth of Missouri River:	
Act of April 28, 1904	212,356.48
Act of March 3, 1905	634,710.56
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Total.....	857,067.04

LIST OF APPROPRIATIONS.

By act of—		By act of—	
June 10, 1872	\$100,000.00	August 18, 1894	\$758,333.33
March 3, 1873	200,000.00	March 2, 1895	758,333.33
June 23, 1874	200,000.00	June 3, 1896	275,000.00
March 3, 1875	200,000.00	June 4, 1897	673,333.33
August 14, 1876	200,000.00	July 19, 1897	325,000.00
June 18, 1878	240,000.00	July 1, 1898	673,333.33
March 3, 1879	200,000.00	March 3, 1899	673,333.33
June 14, 1880	250,000.00	June 6, 1900	100,000.00
March 3, 1881	600,000.00	June 13, 1902	650,000.00
August 2, 1882	600,000.00	March 3, 1903	650,000.00
July 5, 1884	520,000.00	April 28, 1904	650,000.00
August 5, 1886	375,000.00	March 3, 1905	650,000.00
August 11, 1888	300,000.00	Other receipts.....	6,262.38
September 19, 1890	400,000.00		
July 13, 1892	525,000.00		
March 3, 1893	658,333.33		
			12,411,262.38

CONTRACT IN FORCE JUNE 30, 1905.

Name.	Articles.	Rate.	Date of contract (1905).	Date of beginning (1905).	Date of expiration (1905).
Howard Ship Yards Co., Jeffersonville, Ind.	4 wooden flat barges.. 30 wooden flatboats..	\$5,770 each .. 860 each ..	Jan. 31	{ Promptly after signature of contract.	{ June 30 ^a

^a Work suspended, awaiting decision on letter dated May 27, 1905, recommending annulment.

COMMERCIAL STATISTICS.

Receipts and shipments at St. Louis, Mo., during the year 1904.

Receipts:	Tons.
Barbed wire, ores, and metals (pig and manufactured)	
Coal and coke	
Cotton and cotton products	204
Groceries and dairy products	206
Hay, seed, grain, flour, meal, etc.	28,111'
Live stock and products	24,928
Lumber	406
Merchandise and sundries	238,496
Vegetables and fruits	2,879
White lead, oils, etc.	
Wines and liquors	5
Wool	135
Total	295,370
Shipments:	
Barbed wire, ores, and metals (pig and manufactured)	1,851
Coal and coke	6
Cotton and cotton products	303
Groceries and dairy products	5,667
Hay, seed, grain, flour, meal, etc.	10,039
Live stock and products	3,032
Lumber	2,197
Merchandise and sundries	57,668
Vegetables and fruits	1,200
White lead, oils, etc.	1,163
Wines and liquors	439
Wool	
Total	82,565

1594 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Transferred by ferries across the river at St. Louis.

	Tons.
1901.....	5,860,592
1902.....	5,731,635
1903.....	6,328,154
1904.....	6,080,109

Shipments of grain, including flour, meal, etc., and coal down the river from landings between St. Louis and Cairo, during the year 1904, amounted to 43,672 tons.

List of steam-power boats that arrived at St. Louis during the year 1904.

Size of boats.	Draft.	Number.	Times arrived.
Under 500 gross tons.....	<i>Fect.</i> 2.5 to 6	90	1,206
Between 500 and 1,000 gross tons.....	4 to 7.6	9	790
Over 1,000 gross tons.....		0	0
Total.....		99	1,996

List of barges and scows that arrived at St. Louis during the year 1904. ^a

Size of boats.	Draft.	Number.	Times arrived.
Under 500 gross tons.....	<i>Fect.</i> 2.5 to 7.5	271	397
Between 500 and 1,000 gross tons.....	5.2 to 8	7	17
Total.....		278	414

^a Including Government vessels.

Number of vessels, and their tonnage, permanently and temporarily enrolled and licensed at the port of St. Louis, Mo., December 31, 1904. ^a

	No. of vessels.	Gross tonnage.	Net tonnage.
Permanent enrolled steamers (wood).....	67	19,608	17,793
Permanent enrolled steamers (iron and steel).....	9	3,030	2,347
Permanent enrolled barges (wood).....	8	1,151	1,151
Permanent enrolled barges (steel).....	1	1,162	1,162
Permanent enrolled steam yachts (wood).....	3	271	173
Permanent enrolled steam yachts (steel).....	2	177	123
Permanent enrolled sailing yachts (wood).....	0	0	0
Permanent enrolled sailing yachts (steel).....	1	62	62
Temporary enrolled steamers (steel).....	1	25	25
Licensed steamers (wood).....	16	187	149
Licensed steamers (steel).....	2	56	29
Licensed barges.....	1	16	16
Licensed sailing yachts (wood).....	1	9	8
Licensed steam yachts (wood).....	3	35	29
Total.....	115	25,849	23,067

^a Exclusive of Government vessels.

Total cost and work done to June 30, 1905.

Hurdles.	New.	Repairs.		Total cost.
		Restoration.	Maintenance.	
Prior to July 1, 1904.....	<i>Ltn. ft.</i> 400,409	<i>Ltn. ft.</i> 5,925	<i>Ltn. ft.</i> 32,435	\$6,023,059.47
During fiscal year 1905.....	4,350	2,180	2,955	200,212.28
Total.....	411,259	8,115	35,390	6,223,271.75

Total cost and work done to June 30, 1905—Continued.

Bank protection.	Mattress.			Revetment.		Total cost.
	New extensions.		Repairs, maintenance.	New.	Repairs, maintenance.	
	<i>Lin. ft.</i>	<i>Square ft.</i>	<i>Square ft.</i>	<i>Square ft.</i>	<i>Square ft.</i>	
Prior to July 1, 1904.....	258,037	29,987,316	569,455	11,530,182	1,147,500	\$2,544,283.98
During fiscal year ending June 30, 1905.....	34,190	4,095,630	286,420	1,359,954	1,050,092	871,051.44
Total.....	292,227	34,082,946	855,875	12,890,136	2,197,592	2,916,335.42

Recapitulation.

Dikes and dams:		
Prior to July 1, 1904, 39,367 linear feet	\$814,358.33	
During fiscal year 1905		
		\$814,358.33
Jetties:		
Prior to July 1, 1904.....	114,603.53	
During fiscal year 1905.....		
		114,603.53
Dredging:		
Prior to July 1, 1904.....	295,425.19	
During fiscal year 1905.....	62,600.68	
		358,025.87
Surveys, examinations, gauges, etc.:		
Prior to July 1, 1904.....	244,687.98	
During fiscal year 1905.....	13,847.64	
		258,535.62

Recapitulation.

Hurdles	\$6,223,271.75
Bank protection.....	2,930,624.86
Dikes and dams	814,358.33
Jetties	114,603.53
Dredging	358,025.87
Surveys, examinations, gauges, etc.	258,535.62
Total.....	10,699,419.96

Property account.

Class.	Value July 1, 1904.	Debits.	Credits.	Value June 30, 1905.
Steamer Gen. T. L. Casey.....	\$11,025.40	\$14,044.74	\$16,230.63	\$9,433.61
Steamer Gen. H. L. Abbot.....	18,000.30	19,981.00	20,359.80	17,627.62
Steamer Wm. R. King.....	64,776.62	34,150.71	37,387.95	51,638.38
Dredge No. 1.....	6,351.85	34.56	951.62	6,434.89
Dredge No. 2.....	8,483.78	1,857.51	3,082.35	7,258.94
Dredge No. 3.....	81,284.28	16,736.90	20,540.80	76,480.38
Dredge No. 4.....	79,400.90	18,216.95	22,914.22	74,798.69
Steam tenders, wood.....	14,991.37	4,601.50	6,770.50	12,822.37
Steam tenders, steel.....	44,263.34	1,785.79	4,401.75	41,647.38
Barges, model.....	126,857.97	31,797.25	33,522.89	126,132.33
Barges, flat.....		4,993.36	1,298.04	3,695.32
Store boat.....	1,863.78	18.10	287.18	1,594.70
Quarter boats.....	17,894.62	2,697.83	6,281.37	16,311.08
Office and survey boats.....	9,208.59	3,967.15	2,544.11	10,631.63
Pile drivers.....	47,700.17	7,429.56	11,813.37	43,316.36
Derrick boats.....	3,338.79	768.16	672.50	3,492.44
Derricks.....	2,120.95	68.46	374.01	1,814.80
Flats, wood.....		14,603.77	1,092.28	18,471.49
Flats, steel.....	13,109.19		774.76	12,334.43
Small boats.....	20,657.91	7,397.92	25,465.83	2,690.00
Portable quarters.....	1,395.84	781.37	932.90	1,194.31
Jetty gates.....	5,519.46		796.87	4,722.59
Engineer depot.....	10,664.04	12,661.18	8,517.70	20,697.52
Tools and appliances.....	17,200.90	13,487.10	14,518.70	16,169.30
Boarding outfit.....	14,598.13	4,475.89	6,475.72	13,598.30
Office furniture.....	502.62	841.49		844.11
Survey instruments.....	1,199.02	11.48	173.11	1,037.99
Models (Louisiana Purchase Exposition).....	522.12		622.12	
Total.....	618,923.06	216,416.78	240,709.48	688,630.36

1596 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Material account.

Class.	Value July 1, 1904.	Debits.	Credits.	Value June 30, 1905.
Subsistence	\$1,450.07	\$50,160.17	\$55,068.78	\$2,541.51
Piles	3,644.60	47,934.88	37,947.47	13,532.01
Stone	373.03	161,331.07	161,764.72	.....
Rope	30,839.60	16,625.99	13,040.02	34,425.57
Wire	1,083.91	7,200.50	7,226.19	1,118.22
Iron	3,218.12	1,139.27	1,444.37	2,913.02
Nails	1,226.77	1,864.13	1,982.65	608.65
Spikes	1,286.93	471.70	868.20	892.43
Lumber, miscellaneous	9,091.33	22,953.08	17,899.81	16,045.70
Lumber, mattress	38.02	86,681.81	76,641.95	9,077.88
Oakum	652.04	645.00	969.22	327.82
Coal	2,830.27	49,030.03	50,278.38	2,187.92
Ice .....	.....	3,346.47	3,346.47	.....
Material, miscellaneous	14,770.50	21,705.05	23,542.64	12,933.37
Total	71,305.27	470,300.95	462,008.72	95,608.50

Engineer Office, United States Army, in account with United States from 1870 to June 30, 1905.

To allotments, appropriations, etc., prior to July 1, 1904:

1872-1880. Allotment for surveys	\$51,208.77	
1876-1897. Special appropriations	401,600.00	
1879-1904. Miscellaneous receipts	5,860.44	
1872-1904. Appropriations for general improvement	11,770,999.98	
		\$12,238,669.19
Mar. 3, 1905. Appropriation, Mississippi River between Ohio and Missouri rivers	650,000.00	
Mar. 3, 1905. Allotment for survey of harbor and approaches to St. Louis	2,800.00	
		652,800.00

To miscellaneous receipts deposited:

Feb. 6, 1905. Sale of condemned property		2,349.80
June 27, 1905. Unclaimed wages due employees		110.62
Jan. 5, 1905. Disallowed by Auditor for War Department		3.52
Mar. 1, 1905. Refunded for lost anchor		7.50
June 27, 1905. Sale of blueprints		2.13
Sept. 30, 1904. Refunded from allotment for Board of Engineers for Rivers and Harbors		84.20
June 30, 1905. Unpaid percentage on annulled contract ..	\$900.17	
Unpaid percentage on contracts in force ..	7,418.46	
Unpaid labor	9,738.18	
Unpaid miscellaneous	12,905.36	
		30,982.17

Total

12,924,989.13

June 30, 1905. By construction between Illinois and Missouri rivers:

Piasa Island dam	\$37,910.41
Piasa Island dam, cutting channel ..	3,116.86
Alton dam	33,740.05
Alton dike	126,652.74

201,420.06

By construction between Ohio and Missouri rivers ..

9,968,254.94

By jetties

114,603.53

By dredging

358,025.87

By surveys and gauges

258,535.62

By withdrawn for Office of Chief of Engineers

2,220.50

By withdrawn for Board of Engineers for Rivers and Harbors

800.00

By loss account

448,203.42

By property on hand

588,630.96

By material on hand

95,603.50

By models for Louisiana Purchase Exposition, 1904.

522.12

June 30, 1905. By appropriations unexpended:		
Mississippi River, Ohio to Missouri.	\$885,369.21	
Allotment for survey of harbor and approaches to St. Louis.....	2,800.00	\$888,169.21
Total		12,924,989.13

REPORT OF MR. WM. H. MITCHELL, ASSISTANT ENGINEER.

St. LOUIS, Mo., June 30, 1905.

MAJOR: I have the honor to submit the following report of operations for the improvement of the Mississippi River between the mouths of the Ohio and Missouri rivers during the fiscal year ending June 30, 1905:

Works of permanent improvement of various kinds, as will be hereinafter described, were carried on at the following localities: Bank opposite the mouth of the Missouri River, Sawyer Bend, Mo., Pulltong, Ill., Rush Tower, Mo., Osborne Field, Ill., Fish Bend, Ill., Danby Landing, Mo., Penitentiary Point, Ill., Ste. Genevieve, Mo., Horse Island, Mo., Crain Island, Mo., Liberty Bend, Ill., Willard Landing, Ill., Devil Island, Ill., Minton Point, Ill., Cape Girardeau, Mo., Dogtooth Bend, Mo., Greenleaf Bend, Ill., Hurricane Field, Mo., and Greenfield Bend, Mo. Such local surveys and examinations were made as were needed; gauges were read throughout the year and discharge observations were taken throughout the fall season; stone was quarried at Little Rock; the plant was repaired and cared for at the engineer depot, St. Louis, and in the fleets at Claryville, Mo., and Santa Fe, Ill.; dredges were in operation at a number of the bars developed during the low-water season of navigation. In addition there were begun a study for a report on the "Harbor and approaches to St. Louis, with a view to the prevention of floods in the Mississippi River," and designs for the construction of two self-propelling suction dredges of Kappa (M. R. C.) type, as required by acts of Congress approved March 3, 1905.

The conditions of river and weather were most favorable for the prosecution of the work during both fall and spring working seasons, the former remaining at a fairly good boating stage throughout the low-water season and at an unusually moderate stage during the high-water season of the spring and summer, and but little interruption was had from storms or rain during either season. The intervening winter was unusually severe, but on the breaking up of the ice in the spring the numerous and extremely heavy ice gorges which had formed passed out without damage to the plant in harbors opposite Chester, Ill., and Santa Fe, Ill.; though with some destruction of exposed hurdles, notably at Fish Bend, Ste. Genevieve, and Crain Island.

Work was carried on very actively during the fall and preparations had been made to that end for the spring, but the radical change of plan for the improvement of the river in this district enacted in the river and harbor bill of the last Congress caused an absolute suspension of all field work May 1, when the force was disbanded and plant again placed in harbor to await the resumption of dredging in the fall. During the spring season, thus made short, considerable work of repair was done to the hurdles damaged by the ice during the winter.

The organization and superintendence of the field forces for construction works were in the local charges of Assistant Engineers W. M. Penniman and F. Y. Parker and Junior Engineer J. W. Skelly; local surveys, discharge measurements, and buoying the low-water channel were under Assistant Engineer Parker and Junior Engineer Philip Florreich, jr.; the repair and care of all plant, procuring stone at the quarry at Little Rock, and the purchase and distribution of subsistence and supplies were in charge of Assistant Engineer C. D. Lamb.

During his long and severe illness (September to November), and in the spring, while he was engaged upon the designs of dredges and the study for the prevention of floods, the field parties of Mr. Penniman were under the immediate direction of Mr. Jas. E. Kennedy, master of dredge No. 2.

The dredges in operation, Nos. 3 and 4, were in charge of Masters of Dredges Wm. Baxter and L. H. Yourtree, respectively.

Reports from the assistants, giving the details and accompanied by charts showing the locations of the work done, are on file, and are the sources from which this report is largely taken.

The changes in organization were the promotion of Surveyors Daily and Luther to the grade of junior engineer transmitters, the former having been engaged on discharge measurements, gauge records, and maps during the year, and the latter on construction work under the immediate orders of Assistant Parker.

The office has suffered great loss in the death, November 19, of Mr. John Illien, draftsman, who, since 1880, has performed so satisfactorily all the duties of his office.

CONSTRUCTION WORKS.

Midbank distances from the Illinois and St. Louis bridge, St. Louis, are quoted with the notices of work done at the various localities. River stages refer to the St. Louis gauge.

Bank opposite the mouth of the Missouri River (15 miles above St. Louis).--In 1890, 1900, and 1903 the Illinois bank at this locality was continuously protected below the plane of low water with standard mattresses of lumber for 13,770 feet of its length; above these mattresses the bank was completely revetted with stone for 12,500 feet, and partially for the remaining distance.

During the fall season (October and November) the low-water protection was extended 3,850 feet to the head of Chouteau Slough. The stonework of the reach was found in general to be in good condition, but was repaired where necessary, and the completed portion was extended about 800 feet, the remainder of the protected bank being revetted to an average height of the 10-foot stage of river.

The present status of the work is as follows:

	Feet.
Entire length of bank protected with mattress.....	17,620
Length of protection fully completed with stone above the mattress to the average level of 20-foot to 24-foot stages, depending on the height of bank.	13,300
Length of bank at lower end of work, partially protected above mattress with stone to average level of 10-foot stage.....	4,320

In the last stretch the bank was left vertical above the stonework, grading not having been attempted, as it will be accomplished, in great part at least, by the spring high water.

Sawyer Bend, Mo. (7 miles above St. Louis).--In January and February repairs were made, under the inspection and supervision of this office, to the revetment at this place by the Chicago, Burlington and Quincy Railway Company, the original builders of the revetment. About 11,250 square feet of stonework were laid.

Pulltigh, Ill. (15 miles below St. Louis).--At the beginning of the year work was in progress in continuation of the effort to restore the Illinois bank line to the original east channel limit by building short hurdles across the eroded area, the construction of hurdle No. 1 having been begun in June. This hurdle is 900 feet in length, and was fully completed early in July, 300 feet having been built during the month, with buttress and T-head at its outer end.

In October a few repairs were made to hurdle No. 3/8, which had been slightly damaged by the high water of June and July, 1904, and the stone in its T-head was raised and increased in volume.

Osborne Field, Ill. (35 miles below St. Louis).--The Illinois bank at this place having caved rapidly and the channel threatening to follow it and become shoal, it was decided to hold the bank with an extension, upstream, of the original protection in this reach, placed in 1892. Work was begun November 4 and was continued until December 10. A mattress was placed, 3,700 feet in length by only 100 feet in width, narrower than standard width because of the comparatively shallow water encountered. About 1,600 feet of the bank above the mattress were graded and protected with stone to the level of the 19-foot stage; 1,850 feet were graded and revetted to the level of the 11-foot stage, but on account of the lateness of the season the remainder, 250 feet, were not revetted above the mattress.

There is an interval of unprotected bank, about 2,800 feet, between the new work and that of 1892.

Osborne Towhead, Mo. (Rush Tower, Mo., 36 miles below St. Louis).--In October and November repairs were made to the stonework in the revetment on the east side of this towhead, that bank having suffered severely in the last two high waters. The revetment was put in thorough order, and was restored between the 14-foot and 24-foot levels, the work extending along 950 feet of bank.

Fish Bend, Ill. (40 miles below St. Louis).--By gradual erosion the river had become excessively wide at this point and had practically destroyed hurdle No. 3 (built in 1893, although never extended to its full length to the channel limit) and 600 feet of bank protection at the upper end of Rush Towhead. It was decided to restore this bank to the channel limit originally intended, by the construction of a new hurdle

immediately above the wreck of the old one. This was done in October and November. The structure was 1,050 feet in length, and was very strongly built and fully completed with channel-end buttress and T-head.

During the winter the river stage was very low and little or no deposit was secured below the newly built hurdle, and the immense fields of very heavy ice which had formed in the many gorges above its locality, in passing out on the first spring rise, destroyed the greater part of the line, only 385 feet remaining uninjured next the shore, together with another short section 60 feet in length near the outer end of the line. Examination in the spring showed the foundation to be intact; but to allow for unavoidable injury to it in redriving the piling, another mattress 65 feet in width and 950 feet in length was laid over the original foundation across the main gap in the line. The piling was restored and the hurdle was again completed and strengthened, its final length being 1,680 feet from shore to T-head and buttress.

The work of restoration was done March 27 to May 5.

In addition, at this locality, a small hurdle dam 200 feet in length was built in April across a slough 500 feet below hurdle No. 3. The dam is located 550 feet below the head of the slough which it completely closes, and which formerly, at high stages, drew off from the main river a considerable volume of water.

Danby Landing, Mo. (40 miles below St. Louis).—This revetment was begun in 1895, since which time it has been repaired and extended as needed. During the past year, August, September, and November, 1904, and April, 1905, the stonework was thoroughly repaired to the level of the 25-foot stage, and is now entirely complete for 4,750 feet in length between the original ends of the revetment. The mattress was extended in the fall for 3,812 feet along the shore of Lee Island (to station 85-1-50) and the stonework above the new mattress was carried to the level of an 18-foot stage. The remaining height of stonework will be placed after the upper bank has been graded by the high water.

At the head of the work the bank above the 700 feet of mattress placed in 1898 remains unrevetted with stone, but there is as yet no necessity for such completion of the protection.

The entire length of partially and completely protected bank is 9,262 feet.

At station 60, in the revetment, a small slough 65 feet wide (between Ames and Lee islands) was closed by a small and light hurdle dam. This slough parallels the protected bank for about 2,000 feet, at an average distance from it of less than 100 feet. The unrestricted volume of water flowing through it at high stages is considerable and would be a menace to the protection.

Penitentiary Point, Ill. (42 miles below St. Louis).—This revetment was begun in 1900, and was extended and repaired in subsequent years. During the year—July and August—the stonework was very thoroughly repaired and raised to the level of the 25-foot stage.

In a large circular cave in the bank about 1,300 feet below the upper end of the work, a pocket mattress was sunk and a light spur hurdle was built to break the force of the eddy current that had there been formed.

The total length of protection is now 4,220 feet, fully completed.

Ste. Genevieve, Mo. (60 miles below St. Louis).—The protection was placed 1897-1901, and has been repaired since whenever necessary. During the high water of 1904 a cave in the bank occurred about 4,250 feet below the head of the revetment and a spur hurdle to stop the eddy was built in it late in November. In the spring pocket mattresses were built at several places where the revetment had slipped during the winter, and the spur hurdles in former caves were repaired and a new one built at station 27. The entire length of this revetted bank is 5,900 feet, but it requires further minor repairs, work having been stopped at this locality on the suspension of operations in May.

HURDLES.

Hurdle No. 18, built in 1898 at the head of the revetment at this locality, was originally 500 feet in length and was designed to strengthen and protect the upper end of the revetment, but, by gradual encroachment of the river, its length had been reduced to less than 100 feet. The end of the line was strengthened with piling and stone just at the close of the spring season.

Hurdle No. 25.—The high water of last year destroyed about 300 feet of the outer end of this hurdle and left 130 feet more in a weakened condition. This portion of the line was strengthened in November and December, and a new T head was driven at its outer end and was filled with a buttress of stone.

This hurdle suffered severely from ice during the winter, about 250 feet of the piling being destroyed.

*Chester, Mo. (Horse Island, 69 miles below St. Louis).—*The protection was placed in 1897-98. It is 4,346 feet long, but has been badly damaged in the downstream two-thirds of its length.

Repairs had already been begun at the beginning of the fiscal year and were continued during July and August. The stonework at the upper end of the revetment for 1,800 feet, on account of its exposed position, was raised to the top of the bank at about the 34-foot level. Several pocket mattresses were placed and spur hurdles were driven in the caves newly developed in the bank, and those previously driven were strengthened. The remainder of the bank, except 300 feet at the downstream end of the protection, was covered with stone to about the 30-foot level. The total length of completed protection is now about 4,000 feet.

*Crain Island, Mo. (73 miles below St. Louis).—*Hurdle No. 1. Repairs to this hurdle were in progress at the beginning of the year and were completed early in July, but later in that month the high water broke the line for the second time near the middle of the chute. This break, 150 feet in length, was also repaired, though in restoring the line across it about 250 linear feet of new hurdle were built. During the winter a third break was made by the ice, but the damage was slight and was easily repaired in the spring, when also a small accumulation of drift along the west end of the hurdle was sunk as a further protection to that part of the line.

BANK PROTECTION.

The head of Crain Island had been revetted for 1,519 feet in June, 1904, of which length 1,370 feet had been along the outer or main river bank. In August, an extension of this revetment was begun, which was continued intermittently until the bank along the entire present channel-swept river front (6,355 feet) had been protected, the mattress laid this season extending the protection 4,985 feet. Stonework had been laid in June, 1904, above the upper end of the mattress to the bank top. Above this year's extension the stonework was laid to the 26-foot stage as far as station 17, to the 18-foot stage as far as station 53, and for the remaining distance (to station 63+55) to the foot of the abrupt bank at heights varying between the 20-foot and 12-foot stages. Grading was not attempted, the full completion of the stonework having been intended for the coming year, after the passage of the summer high water, which was expected to do the larger part of the grading.

*Liberty Bend, Ill. (81 miles below St. Louis).—*A force was engaged in the repair and extension of the revetment at this place from the latter part of August until the early part of November. The stonework previously laid was thoroughly repaired, and, in addition, about 1,650 feet of bank was completed, making the total length of completed revetment 12,925 feet. A new mattress was built extending the length of the protected bank 2,625 feet, and making the total length of bank, completely and partially protected, 16,025 feet. Above the mattress in the incomplete section (3,400 feet) at the lower end of the work stone was laid to about the level of the 20-foot stage.

In addition, the old subaqueous mattress was repaired or replaced, wherever injured, with small sections of new mattress, and pocket mattresses were built in several slides or caves in the bank.

*Willard Landing, Ill. (111 miles below St. Louis).—*The construction of a hurdle to close the chute between the Illinois shore and the high middle bar opposite Vanell Landing, Mo., was begun June 24, 1904, in the last days of that fiscal year. It was completed July 28. The hurdle is of the usual type, 1,250 feet in length, and in effect is a permeable dam, each end being fixed against a high revetted bank.

*Devil Island, Ill. (121 miles below St. Louis).—*The hurdle across the chute at the head of Devil Island, built in 1897, had suffered severely from floods and ice for several years and was in need of repair. In October the piling was thoroughly restored for 900 feet of the length of the hurdle, and was extended 60 feet to the top of the high island bank, the foundation having been found intact.

In July the stonework in the revetment on the west side of the island was repaired and 2,950 feet of it were raised to the top of the bank at about the 30-foot stage, making the total length of completed revetment 3,800 feet. About 2,850 feet more are incomplete, and vary in height between the levels of the 14-foot and 10-foot stages.

*Minton Point, Ill. (125 miles below St. Louis).—*To relieve the harbor at Cape Girardeau, Mo., which for several years has been obstructed by a persistent and troublesome bar throughout its entire length, and lying close to the paved wharf, a system of four hurdles was designed to project from the Illinois bank above and opposite the town, to contract the waterway and direct the flow into the harbor and thus remove the obstruction. It was decided to build during the past year only two (Nos. 1 and 3) of this series of hurdles.

Hurdle No. 1 was located about 1 mile above the old railway incline at East Cape Girardeau, Ill., and No. 3 was 2,000 feet below No. 1.

The hurdles were begun July 29 and were completed in October. The variations in their structure from the ordinary type were only such as were suggested by the local conditions.

They are 1,000 feet and 1,900 feet, respectively, in length, and are fully completed with well revetted shore ends and T heads and strong riprap buttresses at their channel ends.

In the spring, March 24 to April 15, a drift mattress was built and sunk over the accumulated drift of the winter along the upper side of each hurdle for its entire length.

The effect of these hurdles upon the obstructing bar has been very marked, although the complete result will not be seen until low-water season.

Cape Girardeau, Mo. (124½ miles below St. Louis).—Due to the deflection of the current by the hurdles just built at Minton Point, the Missouri bank, in the spring, began to cave rapidly for nearly half a mile on each side of Sloan Creek, endangering and causing bad slides in the tracks of the St. Louis, Memphis and Southeastern Railway, whose tracks here skirt the high bank, and causing one of the basins of the Cape Girardeau reservoir to settle and crack. To protect this bank a subaqueous mattress, 80 feet wide, was laid in April, in two sections, in length 1,200 feet above and 2,140 feet below Sloan Creek.

Prior to and during the construction of this mattress the St. Louis, Memphis and Southeastern Railway Company was engaged in grading the bank and revetting it with stone heavily laid from the edge of the mattress referred to to the top of the high bank.

Dogtooth Bend, Mo. (166 miles below St. Louis).—Bank protection at this place was begun October 7, the bend having caved as deeply as it was thought advisable to allow it to go. The subaqueous mattress was placed in two sections, an upper section 1,800 feet long, and a lower, 5,665 feet, the two being separated by 4,265 feet of heavily timbered bank, which was not then caving or in need of immediate protection.

The stonework above these mattresses was placed to the foot of the abrupt bank at about the level of the 13-foot stage.

At the lower end of the work (the upper end of Thompsons Bend) the channel leaves the Missouri shore and passes over to Dogtooth Island.

Greenleaf Bend, Ill. (162 miles below St. Louis).—The works at Greenleaf Bend proper and Beechridge are both included in the above caption. They are protection works and have been in progress since 1898. They lie 3,200 feet apart and are 7,575 feet and 10,430 feet long, respectively.

The work of the past season consisted of repairs and the completion of the work previously begun. In the upper stretch, at Greenleaf Bend, the completed work, previously reported, extended to the 30-foot level for 4,600 feet from its upper end. From this point the revetment was raised until at the close of the season the stone was left at the levels of 22-foot to 27-foot stages over a distance of 2,975 feet.

At Beechridge the work was confined to the repair of the lower end of the revetment, about 1,400 feet of the bank being worked upon, leaving the entire work completed to the level of about the 30-foot stage for 9,000 feet in length, thence sloping to the 23-foot level in the following 600 feet and rising again to the 26-foot level throughout the remaining 830 feet.

Hurricane Field, Mo. (165 miles below St. Louis).—The work consisted of the extension and the completion of the protection (5,060 feet long) placed in 1903. The lower end of the work was found to have been damaged by caving banks and was relaid and repaired. The mattress was extended downstream 1,095 feet and upstream, following the caving bank, 2,160 feet. Stone was laid above the new mattresses to the foot of the abrupt bank and the old stonework was raised up the bank, though not to its ultimate full height.

The total revetted bank is now 8,315 feet in length, of which the upper 2,160 feet is protected to the levels of stages 11 feet to 15 feet, the middle 3,100 feet to stages 20 feet to 28 feet, and the lower 3,055 feet to 17-foot to 11-foot levels.

Greenfield Bend, Mo. (172 miles below St. Louis).—Late in November minor repairs were made to this revetment, which was laid in 1903.

The stonework was raised to higher levels for 500 feet at the upper end of the work, and the repairs extended over a total length of 1,500 feet of bank. The revetment, which is 1,925 feet in length, now reaches the levels of stages varying from 20 feet to 16 feet.

A large pile of granite riprap lying out in the steamer channel near this bank, and once forming part of the bank revetment placed for the protection of their incline

1602 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

by the railway companies at Bird Point, became very dangerous on the approach of low water and was demolished by dynamite by the snag boat *Wright* in October.

The following table shows the amounts of work done at the various localities during the fiscal year:

Locality.	Hurdles.			Bank protection.				
	New.	Repairs.		Mattress.		Revetment.		
		Resto- ration.	Mainte- nance.	New extensions.	Repairs and mainte- nance.	New.	Repairs and mainte- nance.	
<i>Lin. ft.</i>	<i>Lin. ft.</i>	<i>Lin. ft.</i>	<i>Lin. ft.</i>	<i>Sq. ft.</i>	<i>Sq. ft.</i>	<i>Sq. ft.</i>	<i>Sq. ft.</i>	
Mouth of Missouri River.....				3,860	501,900		191,010	120,730
Pulltong, Ill.....		300	435					
Osborne Field, Ill.....				3,700	370,000		100,074	
Osborne Towhead, Mo.....								68,380
Fish Bend, Ill.....	200	1,650	1,300					
Danby Landing, Mo.....				3,800	612,800		268,200	87,105
Penitentiary Point, Ill.....						10,400		101,668
St. Genevieve, Mo.....		75	10			19,600		62,380
Chester, Mo. (Horse Island).....						31,120		230,000
Crain Island, Mo.....		165	250	4,985	510,000	78,600		1,875
Liberty Bend, Ill.....				2,625	302,100	140,800	287,300	110,600
Willard Landing, Ill.....	1,250						225,700	
Devil Island, Ill.....			960					35,600
Milton Point, Ill.....	2,000							
Cape Girardeau, Mo.....				3,340	207,200		20,000	
Dogtooth Bend, Mo.....				7,540	906,400		111,200	
Greenleaf Bend, Ill.....							50,120	90,630
Beechbridge, Ill.....							31,000	16,400
Hurlenne Field, Mo.....				4,340	550,270		69,230	31,205
Greenfield Bend, Mo.....								31,710
Total.....	4,350	2,100	2,955	34,190	4,095,630	280,420	1,359,954	1,050,092

TEMPORARY EXPEDIENTS.

Dredging was carried on with dredges Nos. 3 and 4 in commission from July 26 till December 15. The work was not continuous, as the dredged cuts were effective after completion and the general condition of the river channel was satisfactory. During the time of operations 8 feet depth was maintained except for short periods (until a dredge could reach the shoal) when a least depth of 7 feet was found.

On the approach of cold weather the dredges were sent to winter harbor in anticipation of ice. Between this time, November 23, and the close of navigation, the river fell rapidly and the channel depth shoaled to 5 feet.

The following bars were operated upon:

Osborne Towhead.

Little Rock quarry, to remove obstructing bar at lower derriek.

Moro Island railroad incline, to secure channel to railway incline for car transfer boat.

Stanton Crossing.

Grand Tower Island Bend.

Mouth of Big Muddy River, to remove bar obstructing navigation of the Big Muddy River.

Schoenemann Crossing.

Head of Devil Island.

Blackbird Island.

The total amount of sand excavated was about 525,000 cubic yards in nine hundred and eighty-five hours' dredging, or at the rate of 533 cubic yards per dredge hour, and the final cost was about 10 cents per cubic yard, but, of course, this includes the cost of all idle time of the dredges and their crews and the repairs and upkeep of the former during the entire year.

The dredges were in actual operation only about 20 per cent of the time they were in commission. The expense of running them for the entire time would have been increased only by the small charge for fuel and oils, and the reduction in cost for such continuous operation would have been about 75 per cent, or to 2½ cents per yard.

Such fluctuations in the cost of the work are necessarily incident to the demand for dredging and are due to river conditions which can not be anticipated, although the dredges must be held in readiness for any conditions that may arise.

PLANT.

The structures and efficiency of the plant were maintained by extensive and ordinary repairs as were required. No additions were made to any of the classes of the floating plant, but plans were drawn and a contract made for building 4 barges and 30 flatboats, all to be of creosoted wood, to replace vessels that have been worn-out and condemned. The new barges are to be about 50 per cent greater in carrying capacity than those in present use and of scow type instead of with modeled ends. The flats also are to be larger than those now on hand. Actual construction was barely begun by the contractors when, because of the radical change of plan by Congress for the improvement of this section of the river, work was stopped and a proposition was made to the contractor and accepted by him to annul the contract. This was recommended to the Department, but the decision had not been received at the close of the year. Pending the decision work upon the contract is suspended.

The repairs, extensive and ordinary, to all classes of the plant were made in general at the engineer depot, St. Louis, although minor repairs and such preparation of vessels for service as their periodic calking were done in the field and at the fleets.

Towboats.—All of the large steamers—the *Abbot*, *Cusey*, and *King*—received ordinary repairs incident to the usual wear and upkeep. In addition, the *Abbot* was docked in May for the purpose of resecuring the main chains, and advantage was taken of the opportunity to overhaul the hull planking and rudders, and a filtering plant of 100 gallons of clear water per hour was set up in the engine room of the *King*. All three towboats are now in excellent condition for service.

Steam tenders.—The wooden steam tenders, Nos. 3, 4, and 5, have all been docked during the year, the hulls of the first and last being practically rebuilt, and No. 4 is now on the ways undergoing similar repairs.

The newer wooden tenders, Nos. 6 and 7, and the steel tenders, Nos. 8, 9, and 10, which received only minor repairs, are in good condition.

Dredges.—Of the four dredges, No. 1 was condemned and dismantled. This was a jet dredge of very small efficiency, with machinery and cabin mounted on a barge. The machinery will be used for other purposes, the two centrifugal pumps, with their engines, being admirably suited for the jets in the two dredges to be built. The hull will revert to barge service.

Dredge No. 2, a suction dredge with a single "Edwards" 20-inch centrifugal pump, has been put in first-class order, and a quarter boat provided for its crew. The capacity of the dredge is small—only one-half that of dredges Nos. 3 and 4—but it is capable of good work within that capacity, and should be retained for service until the new dredges are secured. Although ready for work during the low-water season, the services of this dredge were not required.

Dredges Nos. 3 and 4 were in commission and in service during the fall, as has been stated. They have been made ready for service again, and are in good condition with the exception of the casings of the main dredging pumps, which are worn and cracked. These casings have been refined and strengthened, and will serve through the coming season, after which they will be replaced by new pumps, for which the designs are prepared. On account of delay which might arise in the delivery of the new pumps it was thought best not to risk changing the machinery with the dredging season so near at hand.

The alteration of the suction heads to dredge going forward or backward and to admit dredging to greater depths than at present is well under way at the shops at the engineer depot, and the changes will be effected this season if it can be done without interfering with the operation of the vessels.

The pipe lines and pontoons for these dredges were cleaned and painted.

The designs for two new dredges of Kappa (M. R. C.) type, with 32-inch centrifugal pumps, are in hand, and the main features of the plan settled upon.

Pile drivers.—The full complement of drivers belonging to this office is 28. Of these, 20 are in good condition and ready for service, 2 of these having been rebuilt during the year. Five other drivers are in need of extensive repairs, and all of these are on the ways in preparation therefor. Another driver (old and in bad condition) was sunk in the spring, and after being raised was found so badly injured as to be unworthy of repair. It has been condemned and dismantled. The hull may be used for one or two seasons more as a field store boat. The 2 pile drivers remaining to be accounted for are in the possession of the Mississippi River Commission, at Memphis, Tenn., having been loaned to the Commission several years ago.

Derrick boats.—Of these there are two, both in good condition, No. 2 having been thoroughly repaired during the year.

Derrick barge.—Is entirely worn-out, and need not be replaced now. The hull should be rebuilt and revert to barge service, and the boilers should be sold. The derrick timbers are rotten, and have been taken down. The hoisting engines are good.

Barges.—There are 61 model available material barges in possession of this office, exclusive of the hulls of dredges Nos. 1 and 2, the derrick barge, and the store boat. Of these, 40 are in good condition for any loads and 21 are available for light service. Of the latter, 10, built in 1895, will soon require very thorough overhauling, and the remaining 11, which were rebuilt in 1898-99, are in somewhat better condition. During the year all barges requiring it received the ordinary repairs, four were rebuilt, and two are now on the ways undergoing repair.

Barge flats.—There are two barge flats, received by purchase from the Missouri River Commission. One of them, the better, No. 4, was rebuilt, and is in use as a wharf boat. The other has been condemned, and will be cut down and used as a hull upon which to mount a steam hammer.

Quarter boats.—There are 10 quarter boats. All have been serviceable throughout the year, although several require repainting, and 3 are now in such bad condition that the hulls should be rebuilt.

Office and survey boats.—These are 5 in number, of which 2 were rebuilt during the year and 2 more require similar repairs within the next year.

Flats, wood.—There are 103 flats on hand, of which 60, built in 1890, are in good condition. The remainder will require extensive repairs to fit them for use. The number available is much too small for a season of active operations of hurdle construction and bank revetment. Ninety flats were repaired and calked during the year.

Flats, steel.—There are 8 mattress way flats of steel, all new and in good condition.

Small boats.—Repairs were made to 8 yawls and 41 skiffs. There are 29 yawls and 127 skiffs on hand, all in fair condition with exception of about 20 of the skiffs.

Tools and appliances, boarding outfit, office furniture, etc.—Were kept in repair and small additions were made to each class to replace articles worn-out and condemned.

Engineer depot.—The shop buildings have been extensively rebuilt with steel frame work covered with corrugated sheet metal, all from old materials on hand, and the old worn-out buildings of wood have been condemned and removed. The following are the new buildings: Sawmill, coal and iron shed, paint and oil house with concrete floor, shop for sheet-iron work, and a shipping platform, the latter with calked deck beneath which is a skiff and tool shed with a cluder and spalls floor. Tanks have been made of old boilers for carrying creosote oil for use in the preservation of boat timbers, and an open treating tank has been installed in which the lumber has been successfully treated. The use of the open-tank process avoids the cost of a pressure plant, but the time of treatment is greatly increased.

MATERIALS.

Of the materials required for construction works the following amounts were procured by contract:

Piles, 9,232 sticks.....	linear feet..	386,713
Mattress lumber.....	feet B. M..	5,746,290
Stone.....	cubic yards..	56,206

The remainder of the piles, 1,754 sticks, 72,350 linear feet, were bought in open market, and the remainder of the stone, 94,631 cubic yards, was procured by hired labor at the quarries at Little Rock Landing, Mo.

At the close of the year 3,278 sticks, 133,504 linear feet of pile timber, and 571,615 feet B. M. of mattress lumber were on hand for future use, and all contracts for such supplies were closed.

QUARRIES.

Owing to the difficulty of getting stone from contractors at reasonable rates and in the vicinity of works of improvement, this office, in 1892, opened quarries at Little Rock Landing, Mo., and has operated them ever since upon payment of royalty to the owners upon the output, thus supplying the stone required over and above that which could be cheaply and readily bought from private parties.

The quarries are two in number, adjoining and having a combined river front of about 1 mile, and are now well equipped with boilers, steam drills, tracks, cars, derricks, tools, shops, and quarters, but the face of the cliff is worked back from the river to such a distance that the use of a central power plant for compressed air for drills and machinery will conduce to marked economy of operations if the quarries are to be used as extensively as heretofore.

The lower quarry has been worked most, but the owner has signified his unwillingness to renew or extend the agreement under which it is now operated, and, if this determination on his part is final, the shops, quarters, etc., now on a part of his property under rental, must be moved by September 16, the date of expiration of the lease, and the tracks, derricks, and all other property belonging to the United States must be removed from the quarry proper by December 31, although until the latter date the quarry may be operated.

The owner of the upper quarry, with its less worked and much larger body of stone, has agreed to extend his lease for five years from January 1, 1906.

During the fall season both quarries were operated and during the spring the lower quarry only, and upon a reduced scale, until the suspension of work.

During the year, 94,628 cubic yards of stone were thus procured, of which the slightly larger portion was from the lower quarry.

Both quarries are now stripped, exposing 30 feet of the ledge, or for about the output for another year. No stripping has been done during the past spring season.

PHYSICAL DATA.

Gauges.—There are 16 river gauges within the district, established and maintained by this office, which have been read daily by appointed observers, two of whom are employees upon other work. Reports are also received from two gauges maintained by the St. Louis Water Department, and from two which are under the Mississippi River Commission.

These 20 gauges are placed at intervals of from 3 to 13 miles apart, between the Chain of Rocks, near the Missouri River, and the mouth of the Ohio River.

Discharge observations.—Fifty-six measurements of the discharge of the river were made at the engineer depot, St. Louis, throughout the fall season, July to December, with full-depth rod floats at stages below 25 feet, completing an annual oscillation of the river at that point. Five measurements above that stage were made at Chester, Ill., for determination of extreme high-water discharge.

The results of this series (for the calendar year 1904) and of those for 1903 and 1900–1901, are shown in the accompanying diagrams,^a in which all the elements of the measurements have been plotted, as well as the resulting curves showing the volumes of discharge, velocities, and areas of cross section for gauge heights at St. Louis, but the data is as yet too meager to throw much light upon the question of the lowering of the slope of the river due to works of improvement, which the observations are intended ultimately to solve.

The observations were discontinued at the beginning of January, with the intention to repeat them at intervals of a few years until the data required has been accumulated.

There is also forwarded a hydrograph of the mean and extreme readings of the St. Louis gauge for the past forty-four years, which may fairly be said to represent the normal conditions of the river.

By your direction, in the fall of 1903, immediately at the close of the season, a line of channel soundings was run from Cairo to Little Rock, 128 miles, where it was stopped because of the ice, although the intention was to have carried the line through to the mouth of the Missouri River, 70 miles farther. Unfortunately, also, the river at the time was at a stage about 3 feet above standard low water, so that the results are probably not quite such as would have been obtained with the river in a more normal low-water condition.

The profile^b from these soundings is shown on the accompanying plate, from which a calculation has been made of the amount of material to be moved ordinarily (by dredges or permanent works) to secure at low water the desired depths of a channel 300 feet wide on the bottom and with side slopes of 4:1, throughout the district. The quantity is 3,500 cubic yards per mile for 16 miles above St. Louis, and 4,700 cubic yards per mile below that city, for the proposed navigable depths of 6 feet and 8 feet, respectively, below standard low water.

The remarkable fact will be noted on this diagram that the average depth of water, throughout the district, at a stage of 6.6 feet on the St. Louis gauge, is nearly 25 feet.

Very respectfully, your obedient servant,

WM. S. MERCHANT,
Assistant Engineer.

Maj. THOS. L. CASEY,
Corps of Engineers.

^a Three only are printed.

^b Not printed.

1606 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Measurements of discharge of the Mississippi River by rod floats, 1904-5.

Dates.	Localities.	Elevations of water surface above St. Louis datum.		Oscillations.	Width of waterway.	Area of entire cross section.	Mean depth.	Elevation of mean bottom above St. Louis datum.	Total volume of discharge.	Mean velocity.	Number of stations.	
		St. Louis gauge, 0 = 164.26 feet above St. Louis datum.	Local gauge.									
		Fect.	Fect.		Fect.	Sq. feet.	Fect.	Fect.	Cu. feet per sec.	Fect per sec.		
1904, July 1	Foot of Arsenal street, St. Louis, Mo.	21.2	190.4	188.0	F	2,607	75,479	28.0	160.0	391,854	5.19	14
6	do.	21.0	187.8	185.5	F	2,669	88,299	26.0	159.9	308,202	4.51	14
8	do.	21.1	187.3	185.0	R	2,557	64,782	25.3	160.0	204,844	4.55	14
13 a. m.	Chester, Ill.	28.4	194.6	190.7	R	2,701	91,906	34.0	116.7	516,255	5.61	13
13 p. m.	do.	28.3	194.5	191.1	R	2,701	94,381	34.0	116.1	513,314	5.44	16
14	do.	28.2	194.5	191.1	S	2,702	94,209	34.0	116.2	520,980	5.63	14
15	do.	27.2	193.5	190.0	F	2,701	93,803	34.7	116.1	504,281	5.38	18
16	do.	25.8	192.0	190.1	F	2,702	91,514	33.0	116.2	476,052	5.19	17
18	Foot of Arsenal street, St. Louis, Mo.	21.5	187.7	180.4	F	2,663	67,948	20.3	160.1	310,217	4.01	14
21	do.	20.3	186.6	185.2	F	2,617	61,122	21.0	161.2	270,809	4.43	14
22	do.	19.0	185.3	181.0	F	2,511	61,946	24.4	159.7	203,619	4.26	13
25	do.	17.2	183.5	182.5	S	2,520	60,410	22.4	160.2	231,789	4.11	14
27	do.	16.5	182.8	181.7	F	2,501	51,940	22.0	159.8	210,408	3.99	14
29	do.	14.7	180.9	180.0	F	2,493	50,575	20.3	159.8	193,360	3.89	14
Aug. 1	do.	12.9	179.2	178.3	F	2,482	45,760	18.4	159.0	165,952	3.63	14
4	do.	11.8	178.0	177.2	F	2,474	44,634	17.8	159.4	148,116	3.36	14
5	do.	11.6	177.8	177.0	F	2,473	43,600	17.0	159.4	147,730	3.39	14
9	do.	10.0	176.2	175.2	F	2,456	39,080	16.9	159.3	121,321	3.11	13
10	do.	9.6	175.8	174.7	F	2,454	37,632	16.3	159.4	116,145	3.07	13
12	do.	8.4	174.7	173.9	F	2,453	36,872	16.0	158.9	109,384	2.97	14
14	do.	8.2	174.4	173.8	R	2,455	37,743	16.4	158.5	110,807	2.94	14
17	do.	8.5	174.7	174.1	S	2,456	38,680	16.7	158.4	114,906	2.98	14
22	do.	11.2	177.5	176.7	F	2,472	44,163	17.0	158.8	147,740	3.35	14
24	do.	12.4	178.6	177.9	F	2,480	47,289	19.1	158.8	162,591	3.44	14
26	do.	12.5	178.8	178.0	R	2,487	48,256	19.4	158.6	171,368	3.55	14
29	do.	10.0	176.3	175.6	F	2,466	40,807	16.6	159.1	129,764	3.18	14
31	do.	8.3	174.5	173.9	F	2,450	37,067	16.1	158.8	109,801	2.90	14
Sept. 1	do.	7.7	174.0	173.4	F	2,453	36,071	14.7	158.7	105,776	2.93	14
6	do.	7.7	173.9	173.3	F	2,454	36,055	14.7	158.0	104,719	2.90	14
7	do.	7.2	173.5	172.9	R	2,454	32,755	13.4	159.5	94,406	2.88	14
10	do.	6.8	173.0	172.5	R	2,442	35,848	13.0	158.6	95,896	2.83	14
12	do.	6.8	173.0	172.5	F	2,442	31,721	13.0	159.5	89,623	2.83	13
20	do.	9.6	175.9	175.2	R	2,466	39,599	16.1	159.1	129,616	3.26	14
21	do.	11.1	177.4	176.7	R	2,475	43,518	17.0	159.2	151,037	3.47	13
24	do.	9.6	175.8	174.4	F	2,468	41,012	16.0	158.8	127,190	3.10	12
28	do.	10.9	177.2	176.5	S	2,476	45,798	18.5	158.0	145,905	3.25	14
29	do.	11.0	177.2	176.6	R	2,476	44,924	18.2	158.4	140,647	3.26	14
Oct. 3	do.	10.7	176.9	176.3	F	2,470	44,144	17.8	158.4	142,005	3.22	14
7	do.	8.8	175.0	174.5	S	2,461	38,232	16.5	158.9	116,853	3.06	13
11	do.	7.8	174.1	173.6	F	2,458	36,587	14.9	158.7	108,620	2.95	18
12	do.	7.7	173.9	173.4	F	2,460	36,904	15.0	158.4	109,766	2.97	13
17	do.	6.7	173.0	172.4	S	2,445	34,217	14.0	158.4	94,094	2.75	19
18	do.	6.7	173.0	172.4	F	2,445	34,741	14.2	158.1	95,188	2.74	19
24	do.	7.1	173.4	172.8	R	2,451	34,869	14.2	158.6	96,033	2.81	17
26	do.	7.7	174.0	173.4	R	2,459	36,881	15.0	158.4	100,978	2.90	18
Nov. 1	do.	9.9	176.1	175.5	S	2,478	41,789	16.9	158.7	132,024	3.10	20
2	do.	9.7	176.0	175.4	S	2,478	42,330	17.1	158.3	131,952	3.12	18
7	do.	8.9	175.2	174.6	F	2,467	40,580	16.5	158.2	119,074	2.93	18
22	do.	6.5	172.7	172.1	F	2,433	33,189	13.6	158.5	91,015	2.74	14
23	do.	6.3	172.5	172.0	F	2,428	33,888	14.0	158.0	90,856	2.68	17
26	do.	5.6	171.9	171.3	F	2,421	31,501	13.0	158.3	85,286	2.70	10
28	do.	5.3	171.6	170.9	S	2,420	31,065	12.8	158.1	79,835	2.57	17
30	do.	5.1	171.4	170.8	F	2,421	30,115	12.4	158.4	79,876	2.65	19
Dec. 5	do.	4.3	170.6	170.1	F	2,416	29,320	12.1	158.0	75,732	2.58	15
6	do.	4.3	170.5	170.1	F	2,415	30,047	12.4	157.6	73,957	2.44	17
8	do.	3.8	170.0	169.4	F	2,415	28,205	11.7	157.7	69,210	2.45	18
9-10	do.	3.7	169.9	169.3	S	2,416	28,113	11.6	157.7	69,248	2.46	18
20	do.	0.5	166.8	166.2	F	2,375	21,179	8.9	157.3	42,830	2.02	16
21	do.	0.4	166.7	166.0	F	2,372	20,950	8.8	157.2	42,539	2.03	17
22	do.	0.2	166.5	165.9	F	2,372	20,346	8.6	157.3	39,196	1.93	16
1905, Jan. 3	do.	1.5	167.8	167.2	R	2,399	23,288	9.7	157.5	53,830	2.31	13

Zero Engineering Department gauge, foot of Arsenal street, is 165.91 feet, St. Louis datum.
Zero, Chester, Ill., gauge is 127.29 feet, St. Louis datum.

Sheet 2

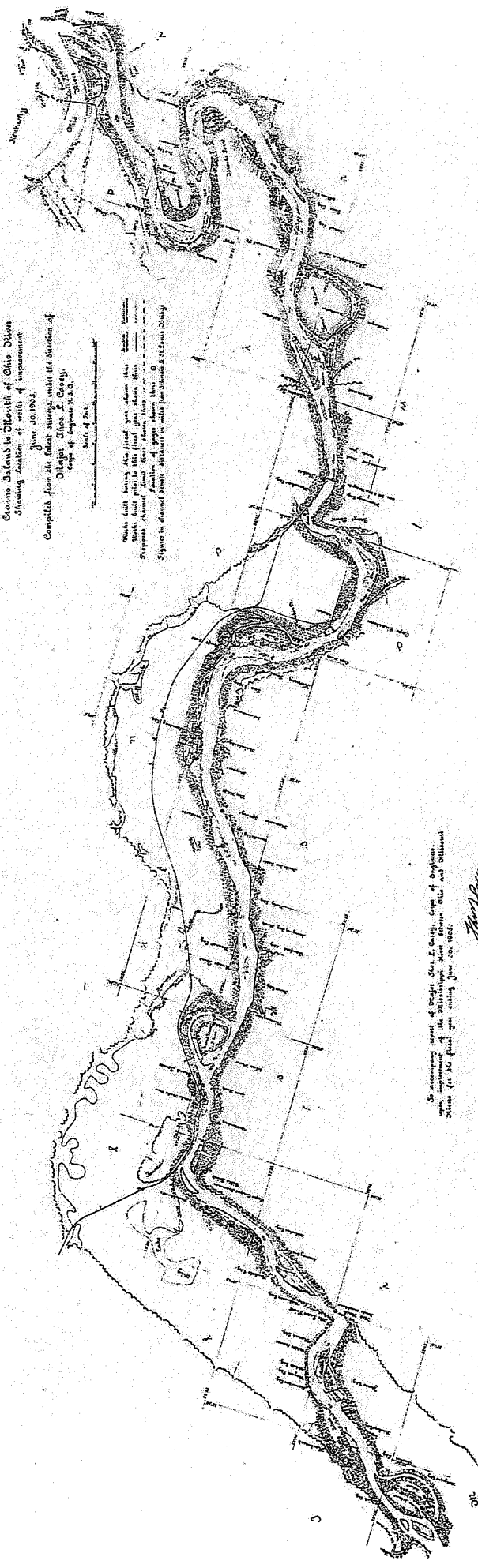
Map of the Mississippi River

Showing Islands in Mouth of Ohio River
Following Location of works of improvement

Compiled from the latest surveys under the direction of
Major John F. Casey,
Chief of Engineers U.S.A.

Scale of Feet

Works built during the fiscal year when this map was published are shown by a thick solid line. Works under construction are shown by a thin solid line. Works proposed are shown by a dotted line. Works authorized but not yet started are shown by a dashed line. Works authorized but not yet started are shown by a dashed line.



In accordance with the report of Major John F. Casey, Chief of Engineers,
U.S.A., submitted to the War Department, June 1865, and
approved by the War Department, June 1865.

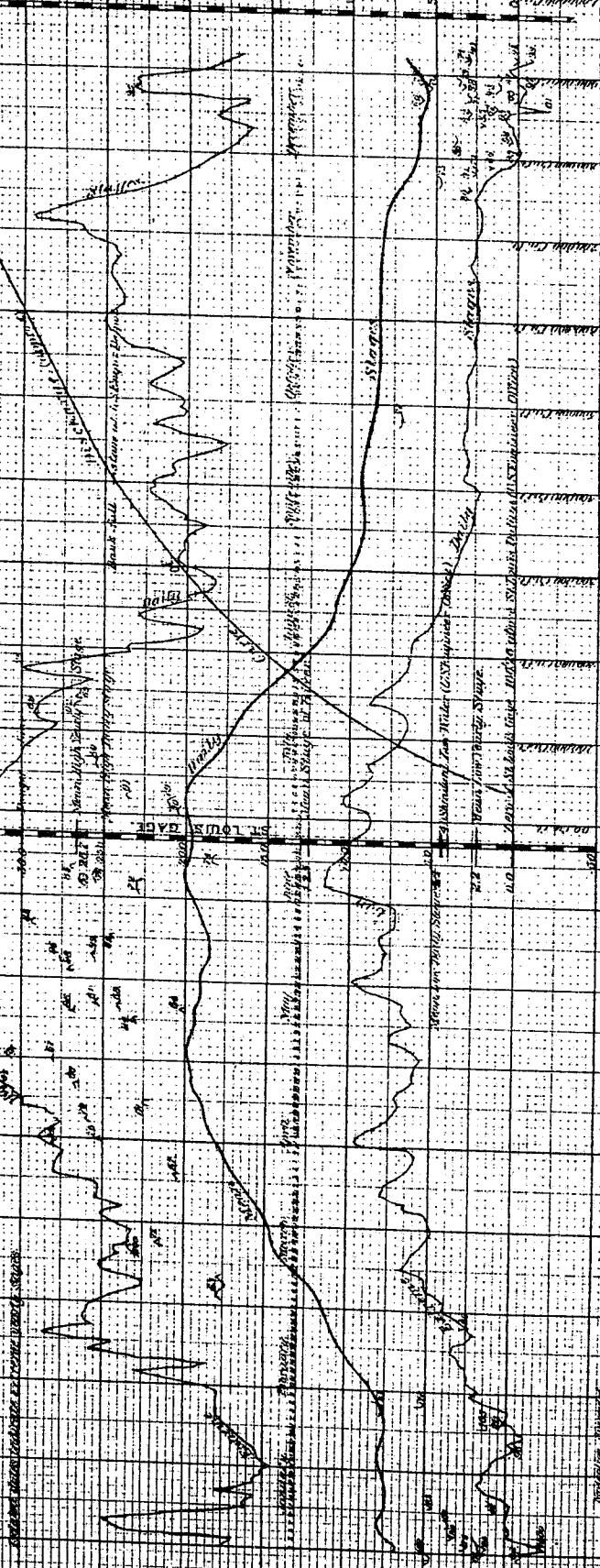
John B. Long
Chief of Engineers U.S.A.

Sheet 1

4547

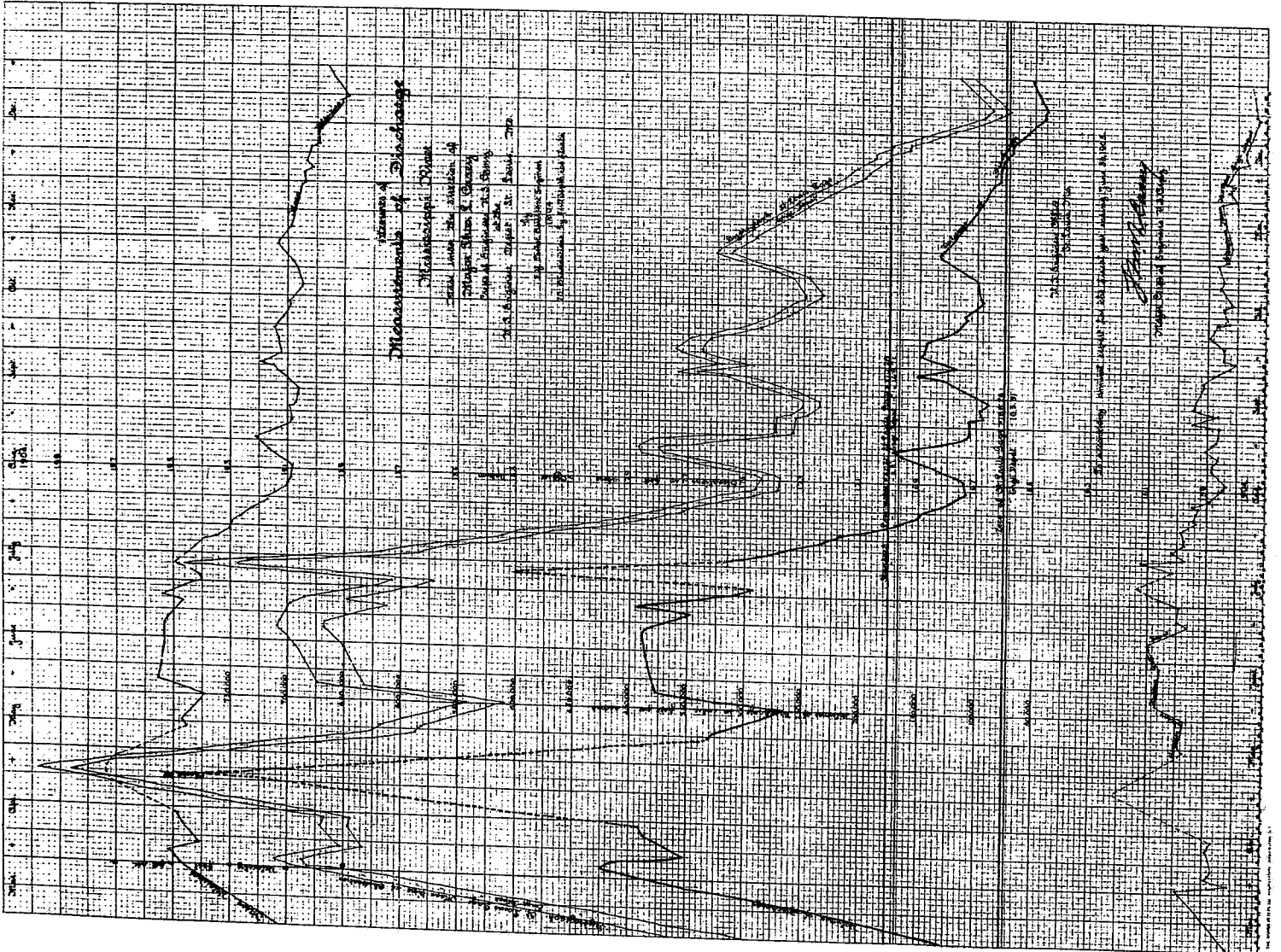
IMPROVING MISSISSIPPI RIVER BETWEEN THE MOUTHS OF OHIO AND MISSOURI RIVERS.

HYDROGRAPHIC MISSISSIPPI RIVER BELOUIS SAGE
MEAN AND EXTREME DAILY STAGES
EXTREME YEARLY STAGES
 DANDY (1810 TO 1819) (1831) (1838)
 FLOW STAGES OF 1795, 1841, 1851, 1858
 MAJOR LOSS - CASEY
 Cause of Engineering History
 by John J. Cassey, Major Engineer



The chart is a hydrograph showing the mean and extreme daily stages of the Mississippi River between the mouths of the Ohio and Missouri rivers. The vertical axis represents the stage in feet, ranging from 0 to 100. The horizontal axis represents time, with major ticks for the years 1795, 1800, 1810, 1820, 1830, 1840, 1850, and 1860. The graph includes several data series: a solid line for the mean stage, a dashed line for extreme daily stages, and a dotted line for extreme yearly stages. Key historical events are marked, such as the 'DANDY STAGE' (1810-1819), 'CASEY STAGE' (1858), and 'FLOOD STAGES OF 1795, 1841, 1851, 1858'. The Casey stage shows a significant peak of about 100 feet around 1858. The mean stage shows a general upward trend over the period shown. The graph is titled 'HYDROGRAPHIC MISSISSIPPI RIVER BELOUIS SAGE' and includes a note about the cause of engineering history by John J. Cassey, Major Engineer.

PREPARED BY GEORGE WYCKSON-HOUSE ET ALIUS, INC.
 ACCOMPANYING APPRAISAL REPORT, JUNE 20, 1917



drift piles removed, and 433,717 trees cut, which greatly improved the river and lessened the dangers of navigation.

Two steel-hull snag boats were employed in removing the obstructions to navigation between the mouth of the Missouri River and Natchez, Miss., and during the year 2,564 snags were pulled, 16 drift piles removed, 14,478 trees cut, and 17,214 miles patrolled.

For information as to the commerce benefited by this work reference should be made to the commercial statistics in the report upon improving the Mississippi River between the Ohio and Missouri rivers and in the reports of the Mississippi River Commission and the district officers thereunder. The amount expended during the year was \$86,386.56.

(See Appendix Y 1.)

2. *Mississippi River between Ohio and Missouri rivers.*—In its original condition the navigable channel of this section of the Mississippi River had a natural depth in many places of only 3½ to 4 feet at low water. The channels were divided by islands, which formed sloughs and secondary channels, or chutes, thru which a great deal of the volume of the flow was diverted, to the detriment of navigation.

The first effort to improve this condition was begun in 1872 and was continued for a number of years as appropriations were made, the works consisting of dikes and dams of brush and stone erected with a view to confining the low-water volume to a single channel and of revetments to hold and preserve the banks where necessary or advisable to do so.

The project followed up to the present time has been that adopted in 1881, approved by letter of the Chief of Engineers dated March 31, 1881, contemplating the confinement of the flow of the river to a single channel having an approximate width below St. Louis of 2,500 feet at bank-full stage, the natural width in many cases being a mile or more at mean high water; this result to be sought by closing sloughs and secondary channels and by building out new banks where the natural width is excessive, using for this purpose permeable dikes or hurdles of piling that collect and hold the solid matter that is carried in suspension or rolled on the bottom of the river; the banks, both new and old, to be revetted or otherwise protected where necessary to secure permanency, and, pending the completion of the permanent improvement, the low-water channel to be improved each season by the use of dredges and other temporary expedients. The cost of the work remaining to be done was estimated in 1903 at \$20,000,000, with annual expenses of \$400,000 for maintenance. It was hoped that the cost might be reduced by increasing the amount of dredging.^a

The river and harbor act of March 3, 1905, appeared to contemplate, however, a permanent departure from the project of 1881, above outlined, in devoting more attention to dredging and less to works of permanent improvement, and authorized the construction of two new hydraulic dredges of the most approved type.

By joint resolution of Congress approved June 29, 1906, the Secretary of War is authorized, in his discretion, to expend any portion of

^a See Annual Report of the Chief of Engineers for 1904, p. 2144 et seq.

the balance now remaining to the credit of this improvement for the repair or completion of improvements already under way or for the construction of other works in accordance with general plans already made or approved, provided that such expenditures shall only be made for improvements which shall be useful for purposes of navigation.

The object of the improvement is to obtain and maintain a minimum depth, at standard low water, of 6 feet from the mouth of the Missouri to St. Louis, and of 8 feet from St. Louis to the mouth of the Ohio.

The amount expended to June 30, 1906, was \$11,594,991.63, exclusive of \$180,000 allotted by acts to projects for improvement between the Illinois and Missouri rivers, including Alton Harbor.

The result of the expenditure of this amount has been the partial improvement of the entire extent of the river from St. Louis to Cairo.

The new appropriation asked for is the estimated expenditure for one year only, and should be increased by authorization under continuing contracts for other years by at least the same sum annually.

It is proposed to expend the new appropriation asked for in dredging and in such temporary and permanent channel improvements as may be authorized by law.

The amount expended during the fiscal year ending June 30, 1906, was \$249,098.48, and includes \$95,998.21 expended for dredging and temporary expedients. The total amount thus far expended for temporary channel improvements is \$789,435.23, much of which has been for plant that is now on hand and available for future work. The approximate value of this plant is \$186,530.80.

Theoretically this improvement should have some influence on freight rates, but an accurate estimation of such effect has been impracticable during recent years.

During the past year there was maintained a channel depth of 8 feet during the entire season unobstructed by ice.

The river at St. Louis reached a high-water stage of 26.2 feet above standard low water on September 21, 1905, and a low-water stage of 1.4 feet above standard low water on December 27, 1905.

With the present appliances and such others as are authorized for the temporary improvement of low-water channels, it is expected that a navigable depth of about 8 feet can be maintained between St. Louis and Cairo during all stages of river open to navigation.

Reference to report on examination and survey of St. Louis Harbor, ordered by the river and harbor act of March 3, 1905, will be found on page 464 of this report.

Recapitulation of commercial statistics.

	1902.	1903.	1904.	1905.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Receipts and shipments at St. Louis.....	641,182	553,617	377,935	370,425
Transferred by ferries at St. Louis.....	5,731,635	0,328,154	6,060,109	6,684,949
Shipped from landings between St. Louis and Cairo...	17,179	43,867	43,672	69,729
Total.....	6,390,000	6,924,638	6,501,716	7,125,103

464 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

July 1, 1905, balance unexpended.....	\$885,369.21
July 1, 1906, miscellaneous receipts.....	5,784.72
	891,153.93
June 30, 1906, amount expended during fiscal year:	
For works of improvement.....	\$214,098.48
For maintenance of improvement.....	35,000.00
	249,098.48
July 1, 1906, balance unexpended.....	642,055.45
July 1, 1906, outstanding liabilities.....	6,671.99
	635,383.46
July 1, 1906, balance available.....	^a 635,383.46
Amount (estimated) required for completion of existing project.....	18,251,654.55
{ Amount that can be profitably expended in fiscal year ending June 30, 1908, for works of improvement and for maintenance, in addition to the bal- ance unexpended July 1, 1906.....	650,000.00
{ Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899. (See Appendix Y 2.)	

EXAMINATION AND SURVEY MADE IN COMPLIANCE WITH RIVER AND HARBOR ACT APPROVED MARCH 3, 1905.

Reports dated April 19 and December 2, 1905, respectively, on preliminary examination and survey required by the river and harbor act of March 3, 1905, of *harbor and approaches to St. Louis, Mo., with a view to preventing floods by reason of obstructions in the Mississippi River*, were submitted thru the division engineer. They were reviewed by the Board of Engineers for Rivers and Harbors, pursuant to law, and were transmitted to Congress and printed in House Document No. 772, Fifty-ninth Congress, first session. The work is not considered one which should be undertaken by the United States.

OPERATING SNAG BOATS AND DREDGE BOATS ON UPPER MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND ST. PAUL, MINNESOTA, AND OF HARBORS AT MOLINE, ILLINOIS, AND LA CROSSE, WISCONSIN; OPERATING AND CARE OF GALENA RIVER IMPROVEMENT, ILLINOIS, AND OF ILLINOIS AND MISSISSIPPI CANAL AROUND THE LOWER RAPIDS OF ROCK RIVER AT MILAN, ILLINOIS.

This district was in the charge of Maj. C. S. Riché, Corps of Engineers. Division engineer, Lieut. Col. W. H. Bixby, Corps of Engineers.

1. *Operating snag boats and dredge boats on upper Mississippi River.*—By the river and harbor act of August 11, 1888, provision was made for securing the uninterrupted work of snag boats and dredge boats on the upper Mississippi River under a permanent appropriation, the sum so expended not to exceed \$25,000 annually.

During the past fiscal year the snag boat *Colonel A. Mackenzie* was

^a Distributed under subheadings as follows:

For protection of bank on Missouri side and to deepen and straighten chan- nel at Wittenberg, Mo., act of March 3, 1899.....	\$10,000.00
For from mouth of Ohio River to mouth of Missouri River—	
Act of April 28, 1904.....	119,061.09
Act of March 3, 1905.....	506,322.37
	635,383.46
Total.....	635,383.46

1402 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The headquarters of the snag boats is in St. Louis.

The amount of customs collected at St. Louis during the fiscal year was \$2,124,322.35.

The amount of internal revenue collected was \$7,708,995.06.

ALLOTMENTS.

Previous to March 3, 1879 (approximated).....	\$358,627.35	Fiscal year ending June 30—	
By act of—		1895.....	\$100,000.00
March 3, 1879.....	100,000.00	1896.....	80,496.26
June 14, 1880.....	100,000.00	1897.....	83,421.61
March 3, 1881.....	80,000.00	1898.....	88,917.74
March 2, 1882.....	85,000.00	1899.....	88,923.15
July 5, 1884.....	72,950.63	1900.....	86,355.29
August 5, 1886.....	56,250.00	1901.....	86,710.05
August 11, 1888.....	100,000.00	1902.....	93,055.27
Fiscal year ending June 30—		1903.....	72,587.48
1890.....	49,089.17	1904.....	88,245.25
1891.....	92,720.97	1905.....	81,822.81
1892.....	98,250.00	1906.....	85,661.36
1893.....	96,497.23	Total.....	2,413,834.11
1894.....	88,252.46		

CONTRACT IN FORCE JUNE 30, 1906.

Name: The A. B. Electric Company, A. Boeschenstein, proprietor.

Work: Electric-light plant, snag boat *H. G. Wright*.

Cost: \$1,453.

Date: May 7, 1906.

Date of commencement: Three days after signature, May 10, 1906.

Date of completion: Sixty days from commencement, July 8, 1906.

Y 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

PROJECT OF 1881, REVISED IN 1883, 1903, AND 1905.

A concise statement of the project for and history of this work will be found in the Annual Report of the Chief of Engineers for 1906, page 462, as well as on page 2631 of the Report of the Chief of Engineers for 1900.

Reference should be made to the Report of the Chief of Engineers, United States Army, for 1894, pages 1577 et seq., for information relating to the development of the various forms of construction and for a résumé of the various types employed between 1872 and 1894, and to the Reports of the Chief of Engineers, United States Army, for 1895, page 2059; 1896, page 1717; 1897, page 2012; 1898, page 1698; 1900, page 2632; and 1901, page 2169; for minor details as to forms of construction.

Since the adoption of this project work has been done substantially according to the methods referred to above at the following localities: Mouth Missouri River, Sawyer Bend, St. Louis Harbor, Cahokia Chute, Arsenal Island, Horsetail bar, Carroll Island, Twin

Hollows, Pulltight, Beards Island, Chesley Island, Jim Smiths, Sulphur Springs, Foster Island, Lucas, Calico Island, Cornice Island, Forest Home, Osborne Field, Rush Tower, Michaels Landing, Fish Bend, Danby Landing, Rush Towhead, Penitentiary Point, Fort Chartres, Crooks, Turkey Island, Mudd Landing, Moro Island, Ste. Genevieve, Fairy Island, Kaskaskia Island, Horse Island, Chester, Crain Island, Liberty Island, Liberty Bend, Seventy-six Landing, Willard, Hamburg, Devil Island, Minton Point, Cape Girardeau, Commerce Island, Burnham Island, Powers Island, Goose Island, Philadelphia Point, Commercial Point, Buffalo Island, Dogtooth Bend, Greenleaf Bend, Beechridge, Hurricane Field, Eliza Point, Greenfield Bend, and vicinity of Cairo.

During the fiscal year ending June 30, 1906, work for the permanent improvement of the river has been carried on, as hereinafter described, at Sawyer Bend and St. Louis Harbor. (See Pl. I.)

The project adopted for the permanent improvement of the Mississippi River between the mouths of the Ohio and Missouri rivers was approved by the Chief of Engineers, United States Army, March 31, 1881. The estimate of the cost, as revised in 1883, was \$16,397,500. The project was modified by the river and harbor act of June 3, 1896, to permit the construction and operation of dredges. It was again modified to some extent in 1903 by the Board of Engineers for Rivers and Harbors in report dated November 12, 1903, the dredging authorization of which was adopted by Congress in the river and harbor act of March 3, 1905.

The interpretation of this act virtually stopt all construction work for the permanent improvement of the river within the district, except for the small unexpended balances from previous appropriations. Attention being called thereto, an unallotted portion of the appropriation was made available by an act approved June 29, 1906, for the construction of works urgently needed, but this act was past too late to be of effect during the fiscal year, and its terms are not yet known to this office.

By the report of 1903 the cost is increased \$20,000,000 in addition to expenditures already made, provided the projects in force be adhered to thruout. The cash expenditures to December 31, 1903, are considered as approximately the cost of the work up to the date of the report of the Board. They were \$10,476,654.53. The total estimated cost as last revised is therefore \$30,476,654.53.

The total amount appropriated to June 30, 1906, was \$12,404,999.98. Of this amount \$180,000 was allotted by acts and projects for improvement between the Illinois and Missouri rivers, including Alton Harbor, leaving a balance of \$12,224,999.98 to be applied to the project for the general improvement between the mouths of the Ohio and Missouri rivers. The balance of the last revised estimate not appropriated June 30, 1906, is therefore \$18,251,654.55.

Under the project submitted May 10, 1905, by the direction of the Chief of Engineers, United States Army, which was approved May 17, 1905, the balance available June 30, 1906, of the appropriation of April 28, 1904, which is \$122,811.67, after deducting outstanding liabilities and amount covered by contract, will be applied during the fiscal year ending June 30, 1907, to emergency works of improvement and for engineering and contingencies.

Under the same project the balance available June 30, 1906, of the appropriation of \$650,000 in the sundry civil act of March 3, 1905, will be applied during the fiscal year ending June 30, 1907, to alterations of dredges on hand, building two dredges, dredging, care of plant, and administration and contingent expenses. The balance available is \$506,322.37.

The river and harbor act approved June 3, 1896, provided:

That any balance of former appropriations now available, and the money hereby appropriated and authorized to be expended for the said section of the river between the mouth of the Missouri River and the mouth of the Ohio River, or so much thereof as may be necessary, shall be expended in the construction of suitable dredge boats, portable jetties, and other suitable appliances, and in the maintenance and operation of the same, with the view to ultimately obtaining and maintaining a navigable channel from St. Louis to Cairo not less than two hundred and fifty feet in width and nine feet in depth at all periods of the year, except when navigation of the river is closed by ice.

In the amount expended is included all amounts expended to June 30, 1906, for dredge plants, portable jetties, and appliances for temporary improvement of the channel and for operating the same, altogether \$789,435.23. Of this, \$95,998.21 was expended during the fiscal year for dredging. The approximate value of this plant at the beginning of the fiscal year was \$168,695.49. Its present approximate value is \$186,530.80.

The river and harbor act approved March 3, 1905, relating to this section of the river reads as follows:

Improving Mississippi River from the mouth of the Ohio River to and including the mouth of the Missouri River: The Secretary of War may prosecute the improvement of the said section of the Mississippi River by dredging, as set forth in the report of the Board of Engineers for Rivers and Harbors, submitted November twelfth, nineteen hundred and three; and the said Secretary of War may purchase or cause to be constructed two dredges to be employed with those now in use in said section for the purpose of dredging; and the said Secretary may, in his discretion, expend a portion of the balance now remaining on hand to the credit of said improvement for the completion of works already under way or for the construction of other works which may be useful in promoting the navigation of said section of the river; and such balance as remains on hand, together with the amount authorized to be expended in pursuance of contracts to be made, is hereby made available for the purpose set forth in this item.

The sundry civil act approved March 3, 1905, making appropriation for this section of the river reads as follows:

Improving Mississippi River from mouth of Ohio River to Minneapolis, Minnesota: For continuing improvement, in completion of contract authorization, from the mouth of the Ohio River to the mouth of the Missouri River, six hundred and fifty thousand dollars. * * *

It is understood that these acts have been modified, as previously stated, by the last Congress (1906), making available for construction of permanent works of improvement a portion of the balance of funds appropriated after the construction of the dredges referred to and the operation of the dredging plant have been provided for. This balance is about \$150,000, out of which must be paid the expenses of the approaching dredging season.

PERMANENT IMPROVEMENT.

Because of the small balance of funds available for the construction of works of permanent improvement such operations were confined to the low-water season or fall of the year and were undertaken at only two places, both in St. Louis Harbor: (1) Sawyer Bend, Missouri,

for the extension upstream of the bank protection at that place, to prevent further recession of the bank and attack of the work already placed, and (2) the construction of hurdles on the Illinois shore between Pittsburg Dike and the Cahokia Ferry Landing, to extend upstream the Arsenal Island system of hurdles, stopping the erosion of the Illinois bank and forcing the river within the harbor limits assigned to it in this section.

The gages were maintained; materials were obtained by contract and purchase in open market; the plant was cared for and repaired at the engineer depot, St. Louis, Mo., and at the fleets at Claryville, Mo., and Santa Fe, Ill.; the dredges were in commission and operation on a number of bars which threatened to become obstructive to navigation; plans and specifications for the construction of two new dredges were drawn and forwarded to the Department for approval, and the alterations to the older dredges were nearly completed; a special survey and report was made of the "Harbor and approaches to St. Louis, with a view to preventing floods by reason of obstructions in the Mississippi River." (River and harbor act approved March 3, 1905.)

The general supervision of engineering operations during the year has been well executed by Mr. Wm. S. Mitchell, and the important care of the engineer depot has, as formerly, been under the effective management of Mr. C. D. Lamb.

CONSTRUCTION WORKS.

Sawyer Bend, Missouri, revetment, 7 miles above Eads Bridge.—Owing to the continued erosion of the Missouri bank for two-thirds of a mile above the revetment placed by the Chicago, Burlington and Quincy Railway in 1901, an extension upstream of the work was intended to have been begun early in the season, but the unusually high river stage which prevailed until October delayed the start until the 23d of that month.

The revetment was extended 3,085 feet upstream, the mattress (only 100 feet wide, because of the proximity of the underlying rock ledge) being completed for that distance, and above its shore edge the bank being faced with stone to the top of the natural slope at about the level of the 20-foot stage. The stonework will be completed to the top of the bank, probably during the coming season or whenever the river at its higher stages shall have graded the bank to proper slope.

During the progress of the work a severe overbank freshet from the Maline Creek cut a series of deeply serrated pockets along 900 feet (stations -19 to -28) of the bank, lowering the latter raggedly to the 14-foot contour. These openings were screened with light pile hurdles faced with open-plank curtains, that the high waters from the Missouri River may fill the basins thus formed with silt and finally restore the bank height, a result partially accomplished by the rise in the spring.

Work upon the revetment extension was completed November 28, when the repair of the old stonework was begun, and at the end of the season the latter was in thoroly good order.

The total length of bank revetted at this locality is now 7,956 feet.

The amount of work done during the year is as follows:

New:

- 309,400 square feet mattress, along 3,085 feet of bank.
- 111,335 square feet stonework, along 3,085 feet of bank.
- Completing this portion of the work to the 20-foot contour above low water.

Repairs:

- 5,000 square feet mattress, along 50 feet of bank.
- 14,495 square feet stonework, along 1,295 feet of bank.
- Restoring to good condition 4,871 feet of revetment (Chicago, Burlington and Quincy, 1901), completed to the top of the bank.

St. Louis Harbor, Illinois, hurdles (Pittsburg dike series) 2½ miles below Eads Bridge.—Three hurdles, Nos. 3, 6, and 9, respectively, and 3,000 feet apart, the first 3,000 feet below Pittsburg dike, and the last 4,000 feet above hurdle No. 1 of the Arsenal Island series (1898), were planned to build out the Illinois bank in that vicinity to the harbor limit, in continuation upstream of the shoreline along the latter hurdles.

Construction was begun August 23, and was prosecuted, with much vexatious delay and damage due to several unwonted, sudden, and great rises in the river, until the lines were completed, December 5.

These hurdles are 675 feet, 831 feet, and 818 feet long, respectively, and are completed from their revetments on the Illinois bank to their T-heads and buttresses at the eastern outer harbor line. The tops of Nos. 3 and 6 reach the level of the 25-foot river stage, but No. 9, because of the short lengths of piling on hand, slopes from the 25-foot stage at the shore to the 18-foot stage in 218 feet of its length, and thence maintains that elevation to its western end.

In form the hurdles are of the ordinary type, and the upper two were strengthened by sinking above them great masses of drift, which accumulated there during construction.

Hurdle No. 3, while incomplete, was broken by the drift along 300 feet of its outer end during the remarkable rise (10-foot stage to 30-foot stage) September 16 to 21, but was soon after thoroly restored and strengthened.

The total length of hurdles built at this locality was 2,324 linear feet.

DREDGING.

Dredges Nos. 2, 3, and 4 were in commission from late in August until early in December, part of the time employed in dredging on bars which seemed to threaten the navigable channel, but which, because of the prevailing high-water stage, did not become obstructive, and during the remainder awaiting the subsidence of numerous sudden rises which occurred thru the season.

Altogether 280,000 cubic yards of material were excavated from the dredge cuts in about one thousand hours of work. At no time during the navigable season of low water, which closed in December on account of ice and cold weather, was there less than 8 feet depth in the channel.

The bars operated upon were at Quarantine, Mo., Whitehouse, Mo., Calico Island Crossing, Little Rock, Mo., Neelys Landing, Mo., Bainbridge, Mo., and excellent channels were obtained at all.

In addition, the railway inclines at Crystal City, Mo., and Little Rock, Mo., were cleared of obstructing sand and the bar at the mouth of Big Muddy River was cut thru to permit access to that stream by lumber craft.

The purpose of the act of 1905, providing for a survey of the harbor and approaches to St. Louis, evidently was the protection from floods of the lowlands adjacent to the harbor of St. Louis, especially the territory in Illinois known as the American Bottoms, the seat of many thriving manufacturing and railway towns suburban to the city of St. Louis; and the survey was intended to serve as the basis of an estimate of cost for the undertaking.

The survey was prosecuted in the field from the middle of July until October, and embraced, with levels and transit location, the water courses and principal features of the entire American Bottoms from Alton, Ill., to Prairie du Pont Creek, an area of about 175 square miles, lying between the Mississippi River and the Illinois bluffs. A large collection of data, pertaining to the various railway, corporation, municipal, and private surveys of the district, was placed at the disposal of the survey party and was reduced to a common plane of reference for elevations and to correct geodetic coordinates for location. An accurate map of the territory was made and a special report upon the contemplated protection was drawn up December 2, 1905, to which reference should be made for the various details, results, and recommendations.

PLANT.

The structures and efficiency of the plant were maintained by extensive or ordinary repairs, as were required. No additions were made to any class of floating plant, but 4 barges (1893) and 1 yawl, old and worn out, for which repair and rebuilding would have required an outlay almost as great as their original cost, were condemned and sold. Jet dredge *No. 1* was condemned and dismantled; those parts of its machinery in good condition and suitable for the service will be used on the new dredges and in other work. In further reduction of plant, already too great for the service under the changed plan of improvement, the construction of 4 wooden barges and 30 flatboats under recent contract was abandoned by agreement and compromise with the contractor, to prevent accumulation of vessels to be cared for and for which there was no prospective use.

Alterations of dredges Nos. 3 and 4.—These dredges were each equipped during the year with new suction heads designed to operate when going ahead or astern, and were fitted with proper appliances for their use. The head of *No. 3* was built in July and August, and was successfully tried during the dredging season. That for *No. 4* was installed in the spring, and is ready for trial during the coming season. As the duplicate pumps originally furnished with each of these dredges were worn out and required renewal, designs were made for new single pumps of the combined capacity (28-inch diameter discharge) of the old pumps, and because of the excessive prices asked by bidders for their supply the patterns were made at the engineer depot and the casting and machining of the parts done in "open market" by local shops and foundries and at the depot. These pumps were installed on the dredges at a cost of about \$1,000 less than the contract proposal, and at the close of the year were nearly ready for operation. These pumps are balanced, 20-inch diameter suction, and are fitted with runners 72 inches diameter, with 6 blades or flukes. They discharge overhead and at either side of the dredge at will and are driven by the old engines, which have been shifted fore and aft in position

for the purpose. The discharge will be made this season thru the old pipe line (24 inches diameter), and then, if experience demands the change, the latter will be enlarged. The pipe lines have also been slightly altered by the omission of the long flexible rubber-sleeve connections between pipe sections in favor of almost rigid connections, with 3-inch rubber gaskets bolted between the end flanges of the pipes. Trial during the last season demonstrated the advantages of this coupling in economy, efficiency, and ease of manipulating the pipe line.

Office and survey boat *No. 4* was docked and thoroly overhauled and repaired, all the parts removed being replaced with creosoted lumber. The boat is still on the ways and all repairs completed except calking.

Extensive repairs and alterations have also been made at the engineer depot. The ironworkers' shop was enlarged and improved, and power tools, punch, rotary shears, and bending rolls installed, the latter being made at the depot. A pattern maker's lathe has been added to the sawmill and grinding mills to the paint house. The coal storage has been enlarged and the shipping platform rebuilt. Most of the alterations in buildings have been made from old materials left on hand in the old jetty gates, the use of which has been abandoned.

Ordinary repairs for their maintenance have been made as they were necessary to all classes of the floating plant and to the tools and appliances.

MATERIALS.

Of the materials used in construction, stone and lumber were purchased by contract. The piles used were on hand from purchases of the previous season.

NEW DREDGES.

Plans and specifications were completed and forwarded for approval for two new dredges, to be self-propelling, with stern wheels, and with main sand pumps of 32-inch diameter of discharge. Their estimated cost, including the ponton pipe lines, is \$330,000.

PHYSICAL DATA.

The gages were maintained and read daily thruout the year and their records were plotted on the hydrograph.

APPROPRIATIONS.

June 10, 1872.....	\$100,000.00	August 18, 1894.....	\$758,333.33
March 3, 1873.....	200,000.00	March 2, 1895.....	758,333.33
June 23, 1874.....	200,000.00	June 3, 1896.....	275,000.00
March 3, 1875.....	200,000.00	June 4, 1897.....	673,333.33
August 14, 1876.....	200,000.00	July 19, 1897.....	325,000.00
June 18, 1878.....	240,000.00	July 1, 1898.....	673,333.33
March 3, 1879.....	200,000.00	March 3, 1899.....	673,333.33
June 14, 1880.....	250,000.00	June 6, 1900.....	100,000.00
March 3, 1881.....	600,000.00	June 13, 1902.....	650,000.00
August 2, 1882.....	600,000.00	March 3, 1903.....	650,000.00
July 5, 1884.....	520,000.00	April 28, 1904.....	650,000.00
August 5, 1886.....	375,000.00	March 3, 1905.....	650,000.00
August 11, 1888.....	300,000.00	Other receipts.....	12,047.10
September 19, 1890.....	400,000.00		
July 13, 1892.....	525,000.00		
March 3, 1893.....	658,333.33		
		Total.....	12,417,047.08

COMMERCIAL STATISTICS.

Receipts and shipments at St. Louis, Mo., during the year 1905.

	Tons.
Receipts:	
Barbed wire, ores, and metals (pig and manufactured)	49
Coal and coke	125,775
Cotton and cotton products	2,058
Groceries and dairy products	1,177
Hay, seed, grain, flour, meal, etc.	27,087
Live stock and products	21,942
Lumber	6,646
Merchandise and sundries	95,808
Vegetables and fruits	9,200
Wines and liquors	8
Wool	106
Total	289,850

Shipments:	
Barbed wire, ores, and metals (pig and manufactured)	1,266
Coal and coke	20
Cotton and cotton products	757
Groceries and dairy products	7,058
Hay, seed, grain, flour, meal, etc.	5,010
Live stock and products	4,756
Lumber	2,152
Merchandise and sundries	46,863
Vegetables and fruits	6,592
White lead, oils, etc.	872
Wines and liquors	5,204
Wool	25
Total	80,575

Transferred by ferries across the river at St. Louis.

	Tons.
1902	5,731,635
1903	6,328,154
1904	6,080,109
1905	6,684,949

Shipments of grain, including flour, meal, etc., and coal down the river from landings between St. Louis and Cairo during the year 1905, amounted to 69,729 tons.

List of steam-power boats that arrived at St. Louis during the year 1905.

[Exclusive of Government vessels.]

Size of boats.	Draft.	Number.	Times arrived.
Under 500 gross tons	<i>Feet.</i> 2.5-6.0	60	1,047
Between 500 and 1,000 gross tons	4.0-7.6	6	538
Total		72	1,585

List of barges and scows that arrived at St. Louis during the year 1905.

[Exclusive of Government vessels.]

Size of boats.	Draft.	Number.	Times arrived.
Under 500 gross tons	<i>Feet.</i> 2.5-7.5	289	372
Between 500 and 1,000 gross tons	5.2-8.0	6	14
Total		295	386

Mississippi River.

Showing location of Works of Improvement at
Sawyer Bend and St. Louis Harbor

June 30, 1906.

Compiled from latest surveys, under the direction of

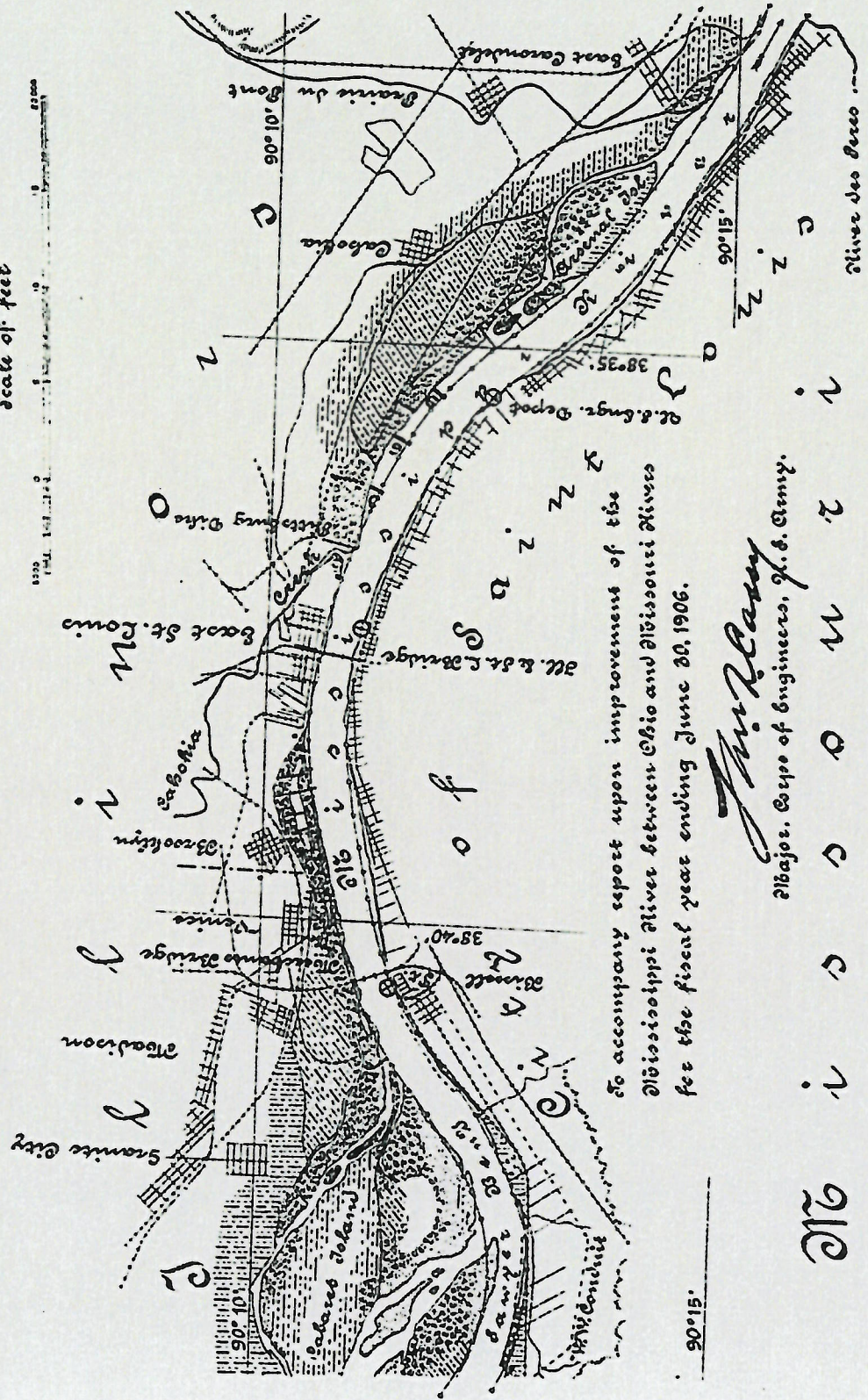
Major Thos. L. Casey,

Corps of Engineers, U. S. Army.

Legend

- Bank protection
- Constructions of this fiscal year
- " " prior to "
- Inner Harbor or Wharf lines of St. Louis
- Location of Sages
- Figures in channel indicate distances in miles from Illinois and St. Louis Bridge.

Scale of feet



To accompany report upon improvement of the
Mississippi River between Ohio and Missouri Rivers
for the fiscal year ending June 30, 1906.

Thos. L. Casey
Major, Corps of Engineers, U. S. Army.

1410 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Number of vessels, and their tonnage, permanently and temporarily enrolled and licensed at the port of St. Louis, Mo., December 31, 1905.

	Number of vessels.	Gross tonnage.	Net tonnage.
Permanent enrolled steamers:			
Wood	65	17,505	16,437
Iron and steel	8	2,814	2,140
Permanent enrolled barges:			
Wood	6	518	518
Steel	1	1,162	1,162
Permanent enrolled steam yachts:			
Wood	4	370	272
Iron and steel	2	177	123
Permanent enrolled sailing yachts, iron and steel	1	62	62
Licensed steamers:			
Wood	16	200	158
Iron and steel	2	56	29
Licensed barges, wood	2	28	28
Licensed sailing yachts, wood	1	9	8
Licensed steam yachts, wood	9	121	98
Total	117	23,022	21,035

Total cost and work done to June 30, 1906.

Hurdles.	New.	Repairs.		Total cost.
		Restoration.	Maintenance.	
Prior to July 1, 1905	<i>Lin. feet.</i> 411,260	<i>Lin. feet.</i> 8,115	<i>Lin. feet.</i> 35,390	\$6,223,271.75
During fiscal year 1906	2,324		300	71,798.16
Total	413,583	8,115	35,690	6,295,069.91

Bank protection.	Mattress.		Revetment.		Total cost.	
	New extensions.	Repairs, maintenance.	New.	Repairs, maintenance.		
Prior to July 1, 1905	<i>Lin. feet.</i> 292,227	<i>Sq. feet.</i> 34,082,040	<i>Sq. feet.</i> 855,875	<i>Sq. feet.</i> 12,890,130	<i>Sq. feet.</i> 2,197,592	\$2,030,624.56
During fiscal year ending June 30, 1906	3,085	309,400	5,000	111,335	30,275	23,177.56
Total	295,312	34,392,346	860,875	13,001,471	2,236,867	2,053,802.12

Dikes and dams:		
Prior to July 1, 1905	39,367 linear feet	\$814,358.33
During fiscal year 1906		
		\$814,358.33
Jetties:		
Prior to July 1, 1905		114,603.53
During fiscal year 1906		
		114,603.53
Dredging:		
Prior to July 1, 1905		358,025.87
During fiscal year 1906		95,998.21
		454,024.08
Surveys, examinations, gages, etc.:		
Prior to July 1, 1905		258,535.62
During fiscal year 1906		12,688.70
		271,224.32

Recapitulation.

Hurdles	\$6,295,069.91
Bank protection	2,953,802.12
Dikes and dams	814,358.33
Jetties	114,603.53
Dredging	454,024.08
Surveys, examinations, gages, etc.	271,224.32
Total	10,903,082.59

Property account.

Class.	Value July 1, 1905.	Debits.	Credits.	Value June 30, 1906.
Steamer Gen. T. L. Casey.....	\$9,433.61	\$486.28	\$1,396.45	\$8,521.44
Steamer Gen. H. L. Abbot.....	17,627.62	7,222.94	9,318.54	15,532.02
Steamer Wm. R. King.....	51,538.38	12,957.21	15,631.88	48,963.71
Dredge No. 1.....	5,434.89		5,434.89	
Dredge No. 2.....	7,258.94	10,631.22	11,102.14	6,788.02
Dredge No. 3.....	76,480.38	17,452.91	17,374.28	76,539.01
Dredge No. 4.....	74,798.69	21,163.63	22,187.73	73,774.80
Dredges Nos. 3 and 4, alterations.....		13,424.21		13,424.21
Dredges Nos. 5 and 6.....		11,943.90		11,943.90
Steam tenders:				
Wood.....	12,822.37	2,839.64	4,316.39	11,345.62
Steel.....	41,647.39	1,260.88	3,565.16	39,343.10
Barges:				
Model.....	125,132.33	14,206.70	31,135.11	108,203.98
Flat.....	3,685.32	6.00	539.51	3,161.81
Store boat.....	1,594.70	102.37	422.51	1,364.56
Quarter boats.....	15,311.08	1,616.41	3,452.46	13,475.03
Office and survey boats.....	10,631.63	4,214.09	3,394.75	11,450.97
Pile drivers.....	43,316.36	3,905.65	9,409.09	37,312.02
Derriek boats.....	3,492.44	137.99	633.54	2,936.89
Derrieks.....	1,814.80		262.01	1,552.79
Flats:				
Wood.....	13,471.49		1,944.04	11,526.55
Steel.....	12,334.43	473.82	1,202.78	11,605.47
Small boats.....	2,500.00	1,693.95	2,068.58	2,215.07
Portable quarters.....	1,104.31	37.74	210.10	1,021.89
Jetty gates.....	4,722.59		681.82	4,040.77
Engineer depot.....	20,697.52	9,076.27	0,070.63	23,703.16
Tools and appliances.....	16,160.30	3,948.50	5,241.48	14,876.32
Boarding outfit.....	13,588.30	722.72	2,967.48	11,353.54
Office furniture.....	844.11		63.31	780.80
Survey instruments.....	1,037.39	159.29	86.30	1,110.38
Total.....	588,630.36	139,774.68	160,017.12	508,387.92

Material account.

Class.	Value July 1, 1905.	Debits.	Credits.	Value June 30, 1906.
Subsistence.....	\$2,541.51	\$16,185.41	\$17,247.18	\$179.74
Piles.....	13,532.01	3,694.25	17,126.26	
Rope.....	34,425.57		15,558.33	18,867.24
Wire.....	1,118.22	11.45	901.40	168.30
Iron.....	2,913.02	2,239.62	1,216.38	3,036.26
Nails.....	608.05	134.23	259.00	482.38
Spikes.....	892.43		151.23	741.20
Lumber:				
Miscellaneous.....	15,045.70	650.36	4,713.54	10,982.22
Mattress.....	9,077.88	5,021.60	13,348.98	1,350.50
Oakum.....	327.82		309.14	18.68
Coal.....	2,187.02	23,024.40	21,153.49	4,658.92
Ice.....		1,166.17	1,166.17	
Material, miscellaneous.....	12,933.37	11,057.07	15,081.56	8,908.88
Stone.....		17,597.05	17,597.05	
Total.....	95,603.50	80,882.33	125,891.51	50,594.32

Engineer Office, United States Army, in account with United States from 1870 to June 30, 1906.

To allotments, appropriations, etc., prior to July 1, 1905:

1872-1905. Allotments for surveys.....	\$54,008.77
1876-1897. Special appropriations.....	401,600.00
1879-1905. Miscellaneous receipts.....	8,418.21
1872-1905. Appropriations for general improvement.....	12,420,999.98
	\$12,894,026.96
July 31, 1905. Allotment for survey of harbor and approaches to St. Louis.....	1,475.00

1412 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

To miscellaneous receipts deposited:

July 31, 1905.	Sale of condemned property		\$1,400.94
Aug. 30, 1905.	Sale of blueprints		2.13
Jan. 25, 1906.	Sale of condemned property		2,589.09
Feb. 26, 1906.	Sale of blueprints		2.13
June 20, 1906.	Sale of condemned property		1,086.86
June 20, 1906.	Received by transfer from Maj. C. S. Riché, for repairs and towing barges		663.90
June 28, 1906.	Unclaimed wages due employees		39.07
June 30, 1906.	Unpaid percentage on annulled contracts	\$900.17	
	Unpaid labor	4,863.54	
	Unpaid, miscellaneous	908.28	
			<u>6,671.99</u>
	Total		<u>12,907,958.67</u>
June 30, 1906.	By construction between Illinois and Missouri rivers:		
	Piasa Island dam	\$37,910.41	
	Piasa Island dam, cutting channel	3,116.86	
	Alton dam	33,740.05	
	Alton dike	126,652.74	
			<u>\$201,420.06</u>
	By construction between Ohio and Missouri rivers:		
	Hurdles	\$6,295,069.91	
	Bank protection	2,953,802.42	
	Dikes and dams	814,358.33	
			<u>10,063,230.66</u>
	Jetties		114,603.53
	Dredging		454,024.08
	Surveys, etc		271,224.32
	By withdrawn for office of Chief of Engineers		2,220.50
	By withdrawn for Board of Engineers for Rivers and Harbors		800.00
	By loss account		538,875.71
	By property on hand		568,387.92
	By material on hand		50,594.32
	By models for Louisiana Purchase Exposition, 1904		522.12
June 30, 1906.	By appropriation unexpended, Mississippi River, Ohio to Missouri		642,055.45
	Total		<u>12,907,958.67</u>

approved March 3, 1879. Specific appropriations or allotments were made for this work each year thereafter, except 1883, 1885, and 1887, but in 1888, by section 7 of the river and harbor act approved August 11, a continuous annual expenditure of \$100,000, or as much thereof as might be necessary, was authorized for the maintenance of this service, and this amount has been available each year since to the present time.

No modification of the project has been made since its adoption, the plan being continuous, new obstructions being brought down by each flood in the river, and so much of the continuous appropriation as may be required each year will be applied to their removal.

The amount expended upon this work prior to June 30, 1872, can not now be ascertained, for the reason that during that time and to March 3, 1879, appropriations were made in lump sums, principally under the titles of "Improvement of Mississippi, Missouri, and Arkansas rivers," to be applied to several streams as their needs or the terms of the laws required, and the available records do not show the amount applied to each stream.

The approximate amount expended from July 1, 1872, to June 30, 1880, was \$493,437.23, and the definitely known amount expended from July 1, 1880, to June 30, 1907, was \$2,006,067.47, making the total of approximate and known expenditures to date \$2,499,504.70.

From March 28, 1868, the earliest date of available record of work done, to June 30, 1907, 88,094 snags were pulled, 52 wrecks and 590 drift piles were removed, and 436,489 trees were cut, greatly improving the river and lessened the dangers of navigation.

Two steel-hull snag boats were engaged in removing the obstructions to navigation between the mouth of the Missouri River and Kennerville, La., a distance of about 1,240 miles. During the year 3,339 snags were pulled, 23 drift piles and 7 wrecks were removed, 2,772 trees were cut, and 21,815 miles patrolled.

For information as to the commerce benefited by this work, reference should be made to the commercial statistics in the report upon improving the Mississippi River between the Ohio and Missouri rivers and in the reports of the Mississippi River Commission and the district officers thereunder. The amount expended during the year was \$85,669.59.

(See Appendix Y 1.)

2. *Mississippi River between Ohio and Missouri rivers.*—In its original condition the navigable channel of this section of the Mississippi River had a natural depth in many places of only 3½ to 4 feet at low water. The channels were divided by islands and bars, which formed chutes and sloughs and secondary channels, through which a great deal of the volume of the flow was diverted, to the detriment of navigation.

The first effort to improve this condition was begun in 1872 and was continued for a number of years as appropriations were made, the works of improvement consisting of dikes and dams of brush and stone to confine the low-water volume in the vicinity to a single channel and of revetments to hold and preserve the banks where it was deemed necessary or advisable to do so.

The project followed in latter years and up to the present time has been that adopted in 1881, approved by letter of the Chief of Engineers dated March 31, 1881, contemplating the confinement of the flow of the river to a single channel having an approximate width below St. Louis of 2,500 feet at bank-full stage, the natural width in many cases being a mile or more at mean high water; this result to be sought by closing sloughs and secondary channels and by building out new banks where the natural width is excessive, using for the purpose permeable dikes or hurdles of piling to collect and hold the solid matter carried in suspension or rolled on the bottom by the river; the banks, both new and old, to be revetted or otherwise protected where necessary to secure permanency. Modifications of the project in the river and harbor acts of 1896 and 1902 provided that, pending the completion of the permanent improvement, the low-water channel be improved each season by the use of dredges and other temporary expedients. By report of a Board of Engineers in 1903 the cost of the work remaining to be done was estimated at \$20,000,000, with annual expenses of \$400,000 for maintenance, but it was hoped that the cost might be materially reduced by a more extensive use of dredging, which was made one of the recommendations.^a

The river and harbor act of March 3, 1905, made a radical departure from the project of 1881, above outlined, confining the work of improvement to dredging and authorizing the construction of two additional hydraulic dredges of the most approved type, which are now in process of construction.

This change of plan threatened to put an end to the work of permanent improvement, but by joint resolution of Congress approved June 29, 1906, the Secretary of War was authorized, in his discretion, to expend any portion of the balance then remaining to the credit of this improvement for the repair or completion of improvements already under way or for the construction of other works in accordance with general plans already made or approved, provided that such expenditures should be made only for improvements useful for purposes of navigation.

The river and harbor act of March 2, 1907, reaffirmed dependence upon dredging as the principal means of improvement, and, as subsidiary thereto, provided also for the maintenance and repair of existing works of permanent improvement, and finally for the construction of similar works with any portion of the appropriation not necessary for the accomplishment of the purposes first named. The allotment, however, was reduced to about 40 per cent of that hitherto usual. Continuing contracts to the amount of \$750,000, yet to be appropriated, were authorized and the expenditure in one year limited to \$250,000 approximately.

Increase is not now recommended, as the amount fixed upon practically indicates the will of Congress until after report of the special survey, for which provision was separately made, having in view an examination and discussion of a plan to be recommended for the future improvement of this section of the river.

^a See Annual Report of the Chief of Engineers for 1904, p. 2144 et seq.

The object of the previous and present plans of improvement is to obtain and maintain a minimum depth at standard low water of 6 feet from the mouth of the Missouri to St. Louis and of 8 feet from St. Louis to the mouth of the Ohio.

The amount expended to June 30, 1907, was \$11,911,830.81, exclusive of \$180,000 allotted by acts to projects for improvement between the Illinois and Missouri rivers, including Alton Harbor.

The result of the expenditure of this amount has been the partial improvement of the entire extent of the river from St. Louis to Cairo.

The new appropriation asked for is the estimated expenditure for one year only, and should be increased by authorization under continuing contracts for other years by at least the same sum annually until the new plan is authorized by Congress.

It is proposed to expend the new appropriation asked for in dredging and in such temporary and permanent channel improvements as may be authorized by law.

The amount expended during the fiscal year ending June 30, 1907, was \$316,839.18, and includes \$105,468.48 expended for dredging. The total amount thus far expended for temporary channel improvements is \$930,067.78, much of which has been for plant that is now on hand and available for future work. The approximate value of this plant is \$211,236.72.

This improvement has probably had a beneficial influence on freight rates, as the rates to localities reached by water are well known to be lower than those remote from this advantage, but an accurate estimation of such effect is impracticable.

During the past year there was maintained a channel depth of 8 feet during the entire season unobstructed by ice.

The river at St. Louis reached a high-water stage of 26.3 feet above standard low water on January 23, 1907, and a low-water stage of 1 foot below standard low water on December 28, 1906.

With the present appliances and such others as are authorized for the temporary improvement of low-water channels it is expected that a navigable depth of about 8 feet can be maintained between St. Louis and Cairo during all stages of river open to navigation.

Recapitulation of commercial statistics.

	1903.	1904.	1905.	1906.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Receipts and shipments at St. Louis	552,617	377,935	370,425	416,856
Transferred by ferries at St. Louis	6,328,154	6,080,109	6,684,949	7,374,978
Shipped from landings between St. Louis and Cairo...	43,867	43,672	69,729	62,238
Total	6,924,638	6,501,716	7,125,103	7,854,071

490 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

July 1, 1906, balance unexpended.....	\$642,055.45
Amount appropriated by river and harbor act approved March 2, 1907.....	250,000.00
June 30, 1907, miscellaneous receipts.....	2,365.33
	894,420.78
June 30, 1907, amount expended during fiscal year:	
For works of improvement.....	\$82,161.72
For maintenance of improvement.....	234,677.46
	316,839.18
July 1, 1907, balance unexpended.....	577,581.60
July 1, 1907, outstanding liabilities.....	30,982.84
	546,598.76
July 1, 1907, amount covered by uncompleted contracts.....	257,443.30
Amount (estimated) required for completion of existing project.....	18,001,654.55
	18,259,097.85
{ Amount that can be profitably expended in fiscal year ending June 30, 1909, for works of improvement and for maintenance, in addition to the balance unexpended July 1, 1907.....	250,000.00
{ Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

(See Appendix Y 2.)

OPERATING SNAG BOATS AND DREDGE BOATS ON UPPER MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND ST. PAUL, MINNESOTA, AND OF HARBOR AT MOLINE, ILLINOIS; OPERATING AND CARE OF GALENA RIVER IMPROVEMENT, ILLINOIS, AND OF ILLINOIS AND MISSISSIPPI CANAL AROUND THE LOWER RAPIDS OF ROCK RIVER AT MILAN, ILLINOIS.

This district was in the charge of Maj. C. S. Riché, Corps of Engineers. Division engineer, Lieut. Col. W. H. Bixby, Corps of Engineers.

1. *Operating snag boats and dredge boats on upper Mississippi River.*—By the river and harbor act of August 11, 1888, provision was made for securing the uninterrupted work of snag boats and dredge boats on the upper Mississippi River under a permanent appropriation, the sum so expended not to exceed \$25,000 annually.

By river and harbor act of March 2, 1907, the annual appropriation for operating snag boats on the upper Mississippi River was made available for similar purposes on the Illinois River from its mouth to Copperas Creek.

During the past fiscal year the snag boat *Colonel A. Mackenzie* was employed from July 1 to November 8, 1906, and from April 23 to June 30, 1907, in removing snags and other obstructions and otherwise assisting the interests of navigation in the Mississippi River between Minneapolis and the mouth of Missouri River and in the Illinois River between its mouth and Copperas Creek.

U. S. dipper dredge *Phoenix* was engaged from August 6 to 21, 1906, in removing obstructions at the steamboat landings at Fulton and Davenport.

U. S. hydraulic dredge *Hecla* was employed August 3 to 8, 1906, in removing deposits at steamboat landing at Keokuk; August 9 to 22 on similar work at Hamburg, and October 15 to 27 in cutting through the bar at Curtis Point.

Summary of expenses for operating U. S. snag boats H. G. Wright and J. N. Macomb, etc.—Continued.

Application.	1907.						Total.
	Jan.	Feb.	Mar.	Apr.	May.	June.	
Office expenses.....	\$715.80	\$66.09	\$685.03	\$885.07	\$711.90	\$16.25	\$3,789.71
Expenses of snag boat H. G. Wright:							
Crew.....	2,042.67	2,065.00	1,981.84	1,626.84	1,795.66	102.49	21,184.67
Outfit.....				846.88	451.00		887.88
Fuel.....	1,058.51	665.65	483.27	334.38	256.05	1,112.47	8,427.82
Subsistence.....	172.60	245.27	374.17	844.88	694.44	431.69	6,200.05
Supplies.....				639.34	120.80		1,064.79
Repairs.....				1,666.45	233.13	28.80	2,494.85
Miscellaneous.....							9.70
Expenses of snag boat J. N. Macomb:							
Crew.....	2,129.00	2,111.00	2,104.00	2,137.67	2,047.73	108.33	22,829.40
Outfit.....					143.22	863.14	1,006.86
Fuel.....	556.65	1,083.85	1,251.20	1,038.93	267.75	162.00	10,496.78
Subsistence.....	733.66	204.62	265.54	549.41	414.97	277.47	6,192.98
Supplies.....				41.79	237.07	130.30	421.80
Repairs.....					1,119.54	1,315.61	2,663.35
Miscellaneous.....							
Total.....	7,408.89	6,431.48	7,145.05	9,561.14	8,493.26	4,548.55	85,669.59

Y 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

PROJECT OF 1881, REVISED IN 1883, 1903, AND 1905.

A concise statement of the project for and history of this work will be found in the Annual Report of the Chief of Engineers for 1906, page 462, as well as on page 2631 of the Report of the Chief of Engineers for 1900.

Reference should be made to the Report of the Chief of Engineers, United States Army, for 1894, pages 1577 et seq., for information relating to the development of the various forms of construction and for a résumé of the various types employed between 1872 and 1894, and to the Reports of the Chief of Engineers, United States Army, for 1895, page 2059; 1896, page 1717; 1897, page 2012; 1898, page 1698; 1900, page 2632, and 1901, page 2169, for minor details as to forms of construction.

Since the adoption of this project work has been done substantially according to the methods referred to above at the following localities: Mouth Missouri River, Sawyer Bend, St. Louis Harbor, Cahokia Chute, Arsenal Island, Horsetail bar, Carroll Island, Twin Hollows, Pulltight, Beards Island, Chesley Island, Jim Smiths, Sulphur Springs, Foster Island, Lucas, Herculanum, Calico Island, Cornice Island, Forest Home, Osborne Field, Michaels Landing, Rush Tower, Fish Bend, Danby Landing, Ames Island, Rush Towhead, Penitentiary Point, Sycamore Landing, Fort Chartres, Crooks, Turkey Island, Mudd Landing, Moro Island, Ste. Genevieve, Fairy Island, Kaskaskia Island, Horse Island, Chester, Crain Island, Liberty Island, Liberty Bend, Lacours Island, Willard, Hamburg, Devil Island, Minton Point, Cape Girardeau, Commerce Island, Burnham Island, Powers Island, Goose Island, Philadelphia Point, Commercial Point,

Prices Landing, Buffalo Island, Dogtooth Bend, Greenleaf Bend, Beechridge, Hurricane Field, Eliza Point, Greenfield Bend, and vicinity of Cairo.

During the fiscal year ending June 30, 1907, work for the permanent improvement of the river has been carried on, as hereinafter described, at Chesley Island, James Landing, Osborne Field, Penitentiary Point, Crain Island, Willard Landing, Devil Island, and Eliza Towhead. (See Pls. I and II.)

The project adopted for the permanent improvement of the Mississippi River between the mouths of the Ohio and Missouri rivers was approved by the Chief of Engineers, United States Army, March 31, 1881. The estimate of the cost, as revised in 1883, was \$16,397,500. The project was modified by the river and harbor act of June 3, 1896, to permit the construction and operation of dredges. It was again modified to some extent in 1903 by the Board of Engineers for Rivers and Harbors in report dated November 12, 1903, the dredging authorization of which was adopted by Congress in the river and harbor act of March 3, 1905.

The interpretation of this act virtually stopped all construction work for the permanent improvement of the river within the district, except for the small unexpended balances from previous appropriations. Attention being called thereto, an unallotted portion of the appropriation was made available by an act approved June 29, 1906, for the construction of works urgently needed.

By the report of 1903 the cost is increased \$20,000,000 in addition to expenditures already made, provided the projects in force be adhered to throughout. The cash expenditures to December 31, 1903, are considered as approximately the cost of the work up to the date of the report of the Board. They were \$10,476,654.53. The total estimated cost as last revised is therefore \$30,476,654.53.

The total amount appropriated to June 30, 1907, was \$12,654,999.98. Of this amount \$180,000 was allotted by acts and projects for improvement between the Illinois and Missouri rivers, including Alton Harbor, leaving a balance of \$12,474,999.98 to be applied to the project for the general improvement between the mouths of the Ohio and Missouri rivers. The balance of the last revised estimate not appropriated June 30, 1907, is therefore \$18,001,654.55.

WORKS OF IMPROVEMENT.

Because of the small balance of funds available, for the reasons stated, operations for the construction of works of permanent improvement were confined to the repair and maintenance of the hurdles and revetments already placed under the original project and to the extension of the system at two places only of those hereinbefore mentioned, at both of which work was urgently required. Three dredges were in commission throughout the fall, operating upon twelve obstructing bars which developed during the low-water season of navigation. The construction of the various parts of the two suction dredges, required by act of Congress approved March 3, 1905, was begun under contract, and at the close of the year fair progress had been made, much delay having been occasioned in procuring structural materials from the steel mills. The alterations to two older dredges were almost completed, having been carried as far as was thought

advisable until after experiment with certain parts during the coming dredging season. Such local surveys and examinations were made as were needed. Gauges were maintained and read throughout the year.

The plant was repaired and cared for at the engineer depot, St. Louis, and in the fleets at Claryville, Mo., and Santa Fe, Ill.

Materials were procured by contract, purchase in open market, and by hired labor, as was deemed most economical and advantageous to the United States. Stone was procured by contract throughout the year, and additional quantities which could not be so procured were quarried during the fall season at Little Rock, Mo., by hired labor. Piling was secured under contract and by purchase in open market. The price of lumber for mattress construction having risen to a figure which made its employment too costly, willow brush, the use of which was discontinued in 1899, was again resorted to and used exclusively, the brush being procured by hired labor.

The stages of the river were generally favorable for work during the fall and spring seasons, as no unusually high or low stages were reached; but the weather during the fall season was marked by frequent heavy rains, which, together with scarcity of labor, made the cost of the work done somewhat higher than it would otherwise have been. The same causes also retarded the delivery of materials, especially piling.

The general supervision of engineering operations during the year has been executed by Mr. Wm. S. Mitchell, assistant engineer. Operations at the engineer depot, the purchase and distribution of subsistence and supplies, the care and repair of plant and procuring stone at the Little Rock quarry were under the superintendence of Mr. C. D. Lamb, assistant engineer. The organization and direction of the field forces for construction were in local charge of Assistant Engineers W. M. Penniman and F. Y. Parker, the former also directing the parties procuring brush and loading pile timber. Local surveys and collection of physical data were under Junior Engineer Philip Florreich, jr. The drafting room was in charge of Junior Engineer J. W. Skelly. Draftsman and Inspector Holland W. Baker was in charge of the design of dredges *Nos. 5 and 6* until the letting of the contract, since which time he has been stationed at Dubuque, Iowa, as the inspector for their construction. Junior Engineer E. C. Constance has been under the personal orders of Assistant Penniman. The dredges in operation, *Nos. 2, 3, and 4*, were in charge of masters of dredge Jas. E. Kennedy, Wm. Baxter, and L. H. Yourtee, respectively.

Reports from these assistants, giving the details and accompanied by charts showing the locations of the various works, are on file. The office has, as heretofore, been in charge of Mr. S. G. Clark, chief clerk.

CONSTRUCTION WORKS.

In the repair and construction of works of permanent improvement during the year the types of hurdles and revetments standard with this office for many years have been used and need not be further described than that the hurdles were permeable dikes of piling driven in one to three rows of three-pile clumps, as was demanded by the depths encountered, through wide foundation mattresses woven of willow brush. The bank revetments were of similar willow mats

extending below the low-water contours to the foot of the bank, with the upper bank surfaces faced with riprap as high as the natural slope would allow, dependence for grading being placed upon succeeding high stages of river, after each of which the stonework will be carried up the bank until the top is reached.

Chesley Island, Missouri (19 miles below Eads bridge, St. Louis). *Repair of bank protection.*—The foundation of this revetment was laid in 1882 and 1883, its original length being about 4,500 feet. The stonework was completed in 1885, since which time slight repairs in several years have been sufficient to maintain the efficiency of the protection. In recent years about 250 feet at the lower end of the work have been slowly worn away, and in 1904 an extraordinary freshet from the Meramec River cut away the entire head of the island behind the revetment, and the portion of the latter thus detached, about 1,300 feet in length, threatened to become an obstruction to navigation. In addition a bank slip about 300 feet in length occurred in the stonework a short distance below the eroded bank.

In October, 1906, to prevent further erosion and damage to the revetment, a protection mattress 875 feet in length was placed along the caving shore at the new head of the island, and above the mattress the bank was revetted with stone to a stage of 13 feet (St. Louis gauge), which was as high as was then practicable without extensive grading. In addition 305 linear feet of mattress, with stonework to the 20-foot stage, were placed in repair of the bank slip referred to.

It is probable that the stonework will be entirely completed during the coming low-water season.

The total length of the protection is now 3,825 feet.

James Landing, Illinois (34 miles below St. Louis). *New bank protection.*—During the last few years the river at this locality had become excessively wide, with consequent bad navigation, the caving on the Illinois shore having entirely destroyed the James Landing hurdles, built 1891 and 1892. In order to check this movement of the channel to the east, and, incidentally, protecting the Monroe County levee, which was endangered, it was decided to extend the Osborne Field revetment upstream. The work was done during September and October (1906), 3,900 feet of mattress being placed, 650 feet of lumber on hand, the remainder, 3,250 feet, of brush, the width varying from 130 feet to 100 feet, depending on the depth of the water. The lower end of the mattress was connected with the shore-end mattress of old hurdle No. 3, thus making the total length of protection above that hurdle 4,030 feet. The entire length of bank along the mattress was graded and revetted with stone to the 14-foot stage, and 500 linear feet were raised to the 16-foot stage.

Osborne Field (36 miles below St. Louis). *Repair of bank protection.*—In order to stop the caving which had been slowly taking place in the bank-behind the revetment at Osborne Field, placed in 1892, and which had reached a maximum width of erosion of 500 feet, two short hurdles were planned to connect the old revetment with the present bank and induce a fill to the former line. Of these only one, hurdle No. 2, was built, November, 1906, its length being 506 feet. The T-head was omitted, as the old revetment was deemed sufficient protection to the outer end.

In addition to the hurdle to check the erosion and rebuild the bank line, the lower end of the caving bank, about 1,400 feet below the

hurdle, was protected by a mattress 400 feet in length and stonework laid on a graded slope to the 16-foot stage. This new revetment lies in the sharp angle between the caving bank and the original revetment which was gradually being destroyed.

In this work there were placed 368 piles, 17 stringers, 118,250 square feet of mattress, and 31,000 square feet of stonework, raised to the 25-foot stage.

Penitentiary Point, Ill. (42 miles below St. Louis). New hurdle for channel contraction.—The first work at this locality was done in 1900, and consisted of a standard bank protection along 6,350 feet of bank, with stonework carried to the 14-foot stage, but about two-thirds of this work was entirely destroyed by the high waters in 1901-2, the bank line receding a maximum distance of about 500 feet. In 1903 another mattress was laid along this unprotected bank, while the remainder of the 1900 revetment was extended upstream to Fish Bend slough, and the stonework for a distance of 4,500 feet below that point was raised to the top of the bank, making the total length of wholly and partially protected bank 7,600 feet.

The spring high water of 1904, strongly deflected against this bank by the caving bank of Ames Island and the fast-growing bar below it, destroyed the lower portion of the new work which had been raised to the 15-foot stage, 3,380 feet being lost. During the following summer the remainder of the work, 4,220 feet, was repaired and raised to the 25-foot stage. The bank below the protection continued to recede, finally endangering the Monroe County levee, and the bar below Ames Island extended rapidly downstream and covered the approach and river front at Brickey Mill, threatening the destruction of river traffic at that landing.

In the spring of 1906, the local interests on both sides demanding it, a survey was made and a project for the construction of two hurdles below Penitentiary Point was submitted and approved. These hurdles were to preserve to navigation Brickey Mill Landing by removing the bar in front to restore the left bank, which had receded at the maximum point more than 2,000 feet, and to insure protection to the levee in Illinois. It was decided, however, to build only one (No. 1) of the hurdles at first and await its results before locating the second structure. Hurdle No. 1, begun in September and completed in November, 1906, is located 3,400 feet below the upper end of Penitentiary Point revetment, using that work for its root at the bank. The hurdle is 1,500 feet in length and its outer end is protected by a modification of the usual buttress and T-head, the latter being in three branches or "crow's foot," designed to govern more effectually the swirl around the end of the hurdle and lessen the eddy below.

In January, 1907, the hurdle was broken by a heavy run of ice and drift, when the stage of the river was abnormally high for that season of the year. Its repair was begun in March and completed early in May.

The repair hurdle bends upstream about 50 feet from the original line and is 450 feet in length.

Slight repairs were also made to the stonework at the shore end of the hurdle.

In May a great quantity of drift which had collected above the hurdle was distributed along the entire length of line and sunk in a mass, 30 feet to 40 feet in width and 5 feet to 15 feet in depth.

In this hurdle there were placed 2,032 piles, 319,600 square feet of foundation mattress, 60,715 square feet of drift mattress, 1,230 square feet of stonework.

It is yet too early to report definitely on the progress of erosion for the removal of the bar threatening Brickey Mill Landing, but there are indications of favorable action as the result of the channel contraction by this hurdle; the caving of the Illinois bank below the hurdle has been markedly checked, and it is thought will have ceased by the time of low water.

Crain Island, Missouri (72 miles below St. Louis). Repair of hurdles.—Both hurdle dams, Nos. 1 and 2, which have been broken for about two years, were repaired in June.

Hurdle dam No. 1.—There were two breaks in this structure which closes "Missouri Chute," their combined length being over 400 feet, both lying within 600 feet of the Puckett Island shore. The repair hurdle, 620 feet in length, was deflected upstream from the original line and joins the Puckett Island shore about 140 feet above the root of the old hurdle. In addition, the shore protection for the new hurdle end was extended as a bank protection 250 feet upstream to the present head of the island.

Hurdle dam No. 2.—The breaks in this hurdle aggregated about 100 feet in length, near the Crain Island side. The original foundation mattress having been found intact, the piling was restored on the old line. The shore protections were repaired and a mass of drift collected above the dam was distributed along the piling and sunk.

In repairs to this hurdle there were placed 615 piles, 30 stringers, 34,100 square feet of mattress, 13,500 square feet of stonework in revetment of the banks.

Bank protection—Revetment.—A large circular cave and eddy, about 125 feet radius, between stations 4 and 9 in the revetment of Crain Island, threatened further destruction of the revetment. To correct this condition and restore the bank lines, a sloping spur hurdle, 125 feet in length, was begun in this pocket and partly completed at the end of the year. The foundation mattress extends out to the old bank protection mattress which was found intact. Pile driving was begun on June 28, but was not completed at the end of the year.

Willard Landing, Illinois (111 miles below St. Louis). Repair of hurdle.—The hurdle dam at this locality, which had been broken for two years, was completed during April and May. All of the stonework and about 200 feet of the piling had been destroyed at the Illinois end of the dam, where the bank line had receded 200 feet.

This repair hurdle runs slightly upstream from the west end of the break in the old line, where the foundation was found intact, to the nearest point on shore, a distance of 350 feet. In addition several weak places in the hurdle were strengthened, so that the total length of piling line repaired was 620 feet.

In this work there were placed 456 piles, 33 stringers, 140,000 square feet of mattress, and 16,500 square feet of stonework in shore protection at the hurdle end.

Devil Island, Illinois (120 miles below St. Louis). Repair of hurdle dam.—The hurdle dam at the head of the island had suffered severely from ice and drift, which had destroyed much of the older piling. At the Illinois, or main-shore, end the connection had been destroyed, and on the hurdle line the bank had caved back a distance of 400 feet, permitting a considerable draft of water into the slough.

Repairs were begun late in June, and at the end of the year a foundation mattress 128 feet in width had been laid from the end of the old structure in a line almost directly upstream to the nearest point on shore, a distance of only 250 feet. Pile driving will be begun and the repairs completed early in July.

Eliza Towhead, Illinois (168 miles below St. Louis). New bank protection.—In 1876 the left bank of the Mississippi River had approached within 3,600 feet of the Ohio River, the narrowest part of the peninsula being near the present northern limits of Cairo, Ill., and the rapid erosion of the bank was naturally viewed with much alarm by its citizens. For the protection of the city and to preserve the regimen of the two rivers at their confluence, a revetment 10,700 feet in length was constructed during 1876, 1878, and 1879 in the bend between the foot of Dickey Island and the stone-spur dikes which had been built by the Cairo Land Company many years before at Eliza Point. In 1881 the channel shifted to the west side of the middle river bar at this place, and the accretions formed thereafter in the bend connected the bar with the mainland. The whole was soon overgrown with willows and the bar became "Eliza Towhead." Since 1896 the right bank of the river about 3 miles above has become deeply eroded, and the channel being sharply deflected by this Missouri bend and the bar below it against the Illinois shore, threatened to destroy Eliza Towhead.

For the protection of these accretions, which have been regarded as adding 1,600 feet to 2,000 feet of bank width to the security of the city of Cairo, a bank revetment was begun and partly completed in November and December, 1906. This revetment thus far is in four intermittent sections, each about 500 feet in length, with an equal interval between sections, thus leaving portions of unprotected bank. As the funds available for this work are limited, this method of extending the length of the protection was adopted, it having given fair results at other places.

There were placed 1,683 linear feet of mattress, thus protecting 3,100 feet of bank line, and as the work was done at high stages of water, the shore edges of the mats were held above the contour of low water and made secure with stone. Riprapping the upper bank was not attempted at the time, it being deemed best to defer that work until the coming season, with the expectation that the intervening high water would grade the bank to proper slope for the reception of the stone.

DREDGING.

Dredges Nos. 2, 3, and 4 were in commission from July 1 to December 15, 1906, and were operated as was necessary throughout the low-water season, and at the approach of winter were withdrawn from service and sent to harbor in anticipation of ice.

As far as was possible, attempt was made to anticipate with the dredges the shoaling on threatening bars to 8-foot depths, and except

at two closely adjacent places, Bee Bluff and Hamburg, governed by the same general conditions, the results were successfully attained, not less than the required depth being maintained throughout the season, although the river fell at the end of October to a stage of 5.8 feet on the St. Louis gauge. At the two places named a depth of 7 feet was had for about two weeks, the channel shifting so often that the dredges were unable to obtain the proper draft through any one dredge cut before the next entire change of channel, but finally the desired line and depth were secured.

The channels generally were in constant use by the river craft to their great relief and advantage.

The bars operated upon were at Pulltight, Chesley Island, Waters Point, Cliffdale Hollow, Grand Tower Island Bend, Crawfords, Willard Landing, Bee Bluff, Hamburg Island, Schenimann, Giboney Island, and Cape Girardeau Bend.

Slight relief was also given to the railway incline at Crystal City, and a navigable entrance was cut into the silted mouth of Big Muddy River for the use of lumber craft.

The total number of dredged channels at the 12 localities named, which are indicated on the accompanying charts, was 17, and their combined length is 34,000 feet.

The total amount of sand excavated was about 1,279,000 cubic yards in 2,125 hours' dredging, or at the rate of 600 cubic yards per dredge hour, and the final cost was about 8½ cents per cubic yard, which includes the cost of all idle time of the dredges and their crews and the repairs and upkeep of the former during the entire year.

The dredges were in operation only about one-third of the time they were in commission. The expense of running them for the entire time would have been increased only by the extra expense for fuel, oils, etc., and the reduction in cost for such continuous operation would have been about 60 per cent, or to 3¼ cents per yard.

Such fluctuations in the cost of the work are necessarily incident to the demand for dredging and are due to river conditions which can not be anticipated, although the dredges must be held in readiness for any conditions that may arise.

PLANT.

The structures and efficiency of the plant were maintained by extensive or ordinary repairs, as were required. No additions were made to any class of floating plant, but four barges and two pile drivers, all thoroughly worn out, were condemned and sold.

Alterations of dredges Nos. 3 and 4.—The installation of new sand pumps on these dredges was completed in August. The pumps were described in the report of this office for 1906 (p. 1407). Their operation has fully justified their construction and the necessary changes in installation, and has increased the efficiency of the dredges about 25 per cent. The new suction head of *No. 4* was not entirely satisfactory, as the throat was found to be too contracted and was often choked by drift and the caving of the face of the cutting, so as to almost entirely shut off the intake, involving considerable loss of time. It was so badly worn during the fall season that a new head was begun during the winter and completed in June. The new head is of the dustpan or shovel pattern, with the lower lip extending 24

inches beyond the upper and in a line with the bottom of the head and suction pipe. The opening is 12 inches deep, but can be closed by choke plates to any lesser opening desired.

Dredge No. 4 has been equipped with 28-inch discharge pipe in place of the 24-inch heretofore used. The deck of *No. 4* was extended back 8 feet over the stern on outriggers, and the cabin will be extended a like distance, to furnish more room for crew and stores. The same changes will be made on *No. 3*, but the 28-inch pipe will be deferred until trial on *No. 4* has demonstrated its superiority.

New dredges.—Contract was entered into December 26, 1906, with the Dubuque Boat and Boiler Works, Dubuque, Iowa, for the construction of hulls, cabins, boilers, propelling machinery, and pontoons for two self-propelling dredges to be known as *Nos. 5* and *6*, authorized by Congress March 3, 1905. After great and vexatious delay by the steel mills most of the material for the hulls has now been received, one of which is now fairly well set up, and riveting has been begun. Contracts were entered into February 6, 1907, with the E. H. Abadie Company, St. Louis, Mo., for the construction of sand pumps and engines, and March 8, 1907, with Schoellhorn-Albrecht Machine Company, St. Louis, Mo., for the construction of the hauling winches. Fair progress has been made in the construction of these machines, and they will probably be ready for delivery in August.

It has been hoped that one, at least, of these dredges would be ready for operation during the approaching low-water season, but the delays referred to have rendered this almost impossible, although the contractors are making every effort to secure the result desired.

Engineer depot, etc.—The buildings and shops at the engineer depot, all machinery, afloat and on shore, all vessels, plant, tools and appliances, etc., have been cared for and the ordinary repairs thereto, necessary for their maintenance and to fit them for the service required, have been made. Extraordinary repairs have been made to the steamer *Wm. R. King*, the boat being thoroughly overhauled for the first time since its launching. The steamer *Gen. H. L. Abbot* was renamed *Gen. J. H. Simpson*, in compliance with departmental instructions concerning the naming of vessels.

Of the floating plant on hand, much is beginning to show the effects of age and work and soon will require extensive repairs or to be dropped from the available list.

MATERIALS.

Of the materials required for construction works, the following amounts were procured by contract:

Piles, 3,429 sticks, 150,748 linear feet; stone, 21,080 cubic yards. The remainder of the piles, 1,369 sticks, were bought in open market, and the remainder of the stone, 10,454 cubic yards, was procured by hired labor at the quarries at Little Rock, Mo., which were in operation from September 18 to November 27, 1906. The brush, 9,634 cords, was procured by hired labor.

PHYSICAL DATA.

The gauges were maintained and read daily throughout the year and their records have been plotted on the hydrograph.

1548 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Money statement.

July 1, 1906, balance unexpended.....		\$042,055.45
Amount appropriated by river and harbor act approved March 2, 1907.....		250,000.00
June 30, 1907, miscellaneous receipts.....		2,365.33
		<hr/>
		894,420.78
June 30, 1907, amount expended during fiscal year:		
For works of improvement.....	\$82,101.72	
For maintenance of improvement.....	234,677.46	
		<hr/>
		316,830.18
July 1, 1907, balance unexpended.....		577,581.60
July 1, 1907, outstanding liabilities.....		30,982.84
		<hr/>
July 1, 1907, balance available.....		546,598.76
July 1, 1907, amount covered by uncompleted contracts.....		257,443.30
Amount (estimated) required for completion of existing project.....	18,001,654.55	
		<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1909, for maintenance of improvement, in addition to the balance unexpended July 1, 1907.....		250,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

June 10, 1872.....	\$100,000.00	March 2, 1895.....	\$758,333.33
March 3, 1873.....	200,000.00	June 3, 1896.....	275,000.00
June 23, 1874.....	200,000.00	June 4, 1897.....	673,333.33
March 3, 1875.....	200,000.00	July 19, 1897.....	325,000.00
August 14, 1876.....	200,000.00	July 1, 1898.....	673,333.33
June 18, 1878.....	240,000.00	March 3, 1899.....	673,333.33
March 3, 1879.....	200,000.00	June 6, 1900.....	100,000.00
June 14, 1880.....	250,000.00	June 13, 1902.....	650,000.00
March 3, 1881.....	600,000.00	March 3, 1903.....	650,000.00
August 2, 1882.....	600,000.00	April 28, 1904.....	650,000.00
July 5, 1884.....	520,000.00	March 3, 1905.....	650,000.00
August 5, 1886.....	375,000.00	March 2, 1907.....	250,000.00
August 11, 1888.....	300,000.00		
September 19, 1890.....	400,000.00		
July 13, 1892.....	525,000.00		
March 3, 1893.....	658,333.33		
August 18, 1894.....	758,333.33		
		Total.....	12,654,999.98
		Other receipts.....	14,412.43
			<hr/>
			12,669,412.41

CONTRACTS IN FORCE.

Name: Dubuque Boat and Boiler Works.
 Work: Parts of two hydraulic dredges.
 Cost: \$238,000.
 Date: December 26, 1906.
 Date of commencement: Ten days after notice of approval.
 Date of completion: April 30, 1908.

Name: The E. H. Abadie Company.
 Work: Four main-pump engines and two centrifugal dredging pumps for two hydraulic dredges.
 Cost: \$34,595.
 Date: February 6, 1907.
 Date of commencement: Promptly after notification of approval.
 Date of completion: March 31, 1908.

able, and, in cutting trees from caving banks to prevent their falling into the river and becoming obstructions to navigation.

The existing project is a continuation of the plan adopted in 1879, when the first specific appropriation for removing snags, wrecks, etc., from the Mississippi River was made by the river and harbor act approved March 3, 1879. Specific appropriations or allotments were made for this work each year thereafter, except 1883, 1885, and 1887, but in 1888, by section 7 of the river and harbor act of August 11, 1888, a continuous annual expenditure of \$100,000, or as much thereof as might be necessary, was authorized for the maintenance of this service, and this amount has been available each year since to the present time.

No modification of the project has been made since its adoption, the plan being continuous, new obstructions being brought down by each flood in the river, and so much of the continuous appropriation as may be required each year will be applied to their removal.

The amount expended upon this work prior to June 30, 1872, can not now be ascertained, for the reason that during that time and to March 3, 1879, appropriations were made in lump sums, principally under the titles of "Improvement of Mississippi, Missouri, and Arkansas rivers," to be applied to several streams as their needs or the terms of the laws required, and the available records do not show the amount applied to each stream.

The approximate amount expended from July 1, 1872, to June 30, 1880, was \$493,437.23, and the definitely known amount expended from July 1, 1880, to June 30, 1908, was \$2,103,956.82, making the total of approximate and known expenditures to date \$2,597,394.05.

From March 28, 1868, the earliest date of available record of work done, to June 30, 1908, 91,838 snags were pulled, 58 wrecks and 609 drift piles were removed, and 441,664 trees were cut, greatly improving the river and lessening the dangers of navigation.

Two steel-hull snag boats were engaged in removing the obstructions to navigation between the mouth of the Missouri River and New Orleans, La., a distance of about 1,270 miles. During the year 3,744 snags were destroyed, 19 drift piles and 6 wrecks were removed, 5,175 trees were cut, and 20,811 miles patrolled.

A part of the funds appropriated for the removal of obstructions was expended in the partial removal of Beaver Dam rock, an obstructive and dangerous rock lying in mid-channel about 1 mile below Commerce, Mo. A beginning was made upon this work, which can only be done economically at low and favorable river stages, and it will be continued until completed as opportunity offers and funds are available.

For information as to the commerce benefited by this work, reference should be made to the commercial statistics in the report upon improving the Mississippi River between the Ohio and Missouri rivers and in the reports of the Mississippi River Commission and the district officers thereunder. The amount expended during the year was \$97,889.35.

(See Appendix Y 1.)

2. *Mississippi River between Ohio and Missouri rivers.*—In its original condition the navigable channel of this section of the Mississippi River had a natural depth in many places of only $3\frac{1}{2}$ to 4

feet at low water. The main channels were divided by islands and bars, which formed chutes and sloughs and secondary channels, through which a considerable part of the volume of the flow was diverted, to the detriment of navigation.

The first effort to improve this condition was begun in 1872 and was continued for a number of years as appropriations were made, the works of improvement consisting of dikes and dams of brush and stone to confine the low-water volume in the vicinity to a single channel and of revetments to hold and preserve the banks where it was deemed necessary or advisable to do so.

The project followed in latter years and up to the present time has been that adopted in 1881, approved by letter of the Chief of Engineers dated March 31, 1881, contemplating the confinement of the flow of the river to a single channel having an approximate width below St. Louis of 2,500 feet at bank-full stage, the natural width in many cases being a mile or more at mean high water; this result to be secured by closing sloughs and secondary channels and by building out new banks where the natural width is excessive, using for the purpose permeable dikes or hurdles of piling to collect and hold the solid matter carried in suspension or rolled on the bottom by the river; the banks, both new and old, to be revetted or otherwise protected where necessary to secure permanency. Modifications of the project in the river and harbor acts of 1895 and 1902 provided that, pending the completion of the permanent improvement, the low-water channel be improved each season by the use of dredges and other temporary expedients. By report of a Board of Engineers in 1903 the cost of the work remaining to be done was estimated at \$20,000,000, with annual expenses of \$400,000 for maintenance, but it was hoped that the cost might be materially reduced by a more extensive use of dredging, which was made one of the recommendations. (See Annual Report of the Chief of Engineers for 1904, p. 2144 et seq.)

The river and harbor act of March 3, 1905, made a radical departure from the project of 1881, above outlined, confining the work of improvement to dredging and authorizing the construction of two additional hydraulic dredges of the most approved type, which will be available during the coming low-water season.

This change of plan threatened to put an end to the work of permanent improvement, but by joint resolution of Congress approved June 29, 1906, the Secretary of War was authorized, in his discretion, to expend any portion of the balance then remaining to the credit of this improvement for the repair or completion of improvements already under way or for the construction of other works in accordance with general plans already made or approved, provided that such expenditures should be made only for improvements useful for purposes of navigation.

The river and harbor act of March 2, 1907, reaffirmed dependence upon dredging as the principal means of improvement, and, as subsidiary thereto, provided also for the maintenance and repair of existing works of permanent improvement, and finally for the construction of similar works with any portion of the appropriation not necessary for the accomplishment of the purposes first named. The allotment, however, was reduced to about 40 per cent of that hitherto usual. Continuing contracts to the amount of \$750,000, of which

\$500,000, is yet to be appropriated, were authorized and the expenditure in each year limited to \$250,000 approximately.

Increase is not now recommended, as the amount fixed upon practically indicates the will of Congress until after report of the special survey, for which separate provision was made, having in view an examination and discussion of a plan to be recommended for the future improvement of a part of the river, including this section.

The object of the previous and present plans of improvement is to obtain and maintain a minimum depth at standard low water of 6 feet from the mouth of the Missouri to St. Louis and of 8 feet from St. Louis to the mouth of the Ohio.

The amount expended to June 30, 1908, was \$12,376,301.59, exclusive of \$180,000 allotted by acts to projects for improvement between the Illinois and Missouri rivers, including Alton Harbor.

The result of the expenditure of this amount has been the partial improvement of the entire extent of the river from St. Louis to Cairo.

The new appropriation asked for is the estimated expenditure for one year only, and should be increased by authorization under continuing contracts for other years by at least the same sum annually until the new plan is authorized by Congress.

It is proposed to expend the new appropriation asked for in dredging and in such temporary and permanent channel improvements as may be necessary and authorized by law.

The amount expended during the fiscal year ending June 30, 1908, was \$464,470.78, and includes \$102,710.89 expended for dredging. The total amount thus far expended for temporary channel improvements is \$1,032,778.47, much of which has been for plant that is now on hand and available for future work. The approximate value of this plant is \$414,031.99.

This improvement has probably had a beneficial influence on freight rates, as the rates to localities reached by water are well known to be lower than those remote from this advantage, but an accurate estimation of such effect is impracticable.

During the past year there was maintained a channel depth of 8 feet during the entire season when unobstructed by ice, except in November when, for short periods at several places, the depths were 7 feet until dredges could be brought into action upon these shoals, when the required depth was quickly obtained.

The river at St. Louis reached a high-water stage of 30.9 feet above standard low water (4 feet St. Louis gauge) on June 20, 1908, and a low-water stage of 2.3 feet below standard low water on February 4, 1908.

With the present appliances and such others as are authorized for the temporary improvement of low-water channels it is expected that a navigable depth of about 8 feet can be maintained between St. Louis and Cairo during all stages of river open to navigation.

Recapitulation of commercial statistics.

	1904.	1905.	1906.	1907.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Receipts and shipments at St. Louis	377,935	370,425	416,855	368,075
Transferred by ferr.es at St. Louis	6,080,109	6,684,949	7,374,978	8,303,542
Shipped from landings between St. Louis and Cairo.	43,672	68,729	62,238	65,467
Total	6,501,716	7,125,103	7,854,071	9,339,084

RIVER AND HARBOR IMPROVEMENTS.

523

July 1, 1907, balance unexpended.....		\$577,551.60
Amount appropriated by sundry civil act approved May 27, 1908..		250,000.00
June 30, 1908, miscellaneous receipts.....		13,533.91
		<hr/>
		841,174.64
June 30, 1908, amount expended during fiscal year:		
For works of improvement.....	\$68,061.21	
For maintenance of improvement.....	396,409.57	
		<hr/>
		464,470.78
July 1, 1908, balance unexpended.....		376,703.86
July 1, 1908, outstanding liabilities.....		21,709.98
		<hr/>
July 1, 1908, balance available.....		354,993.88
		<hr/>
July 1, 1908, amount covered by uncompleted contracts.....		68,738.17
Amount (estimated) required for completion of existing project..		17,751.651.53
		<hr/>
Amount that can be profitably expended in fiscal year ending June 30, 1910, for works of improvement and for maintenance, in addition to the balance unexpended July 1, 1908.....		250,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

(See Appendix Y 2.)

IMPROVEMENT OF RIVERS AND HARBORS IN THE ROCK ISLAND, ILLINOIS, DISTRICT.

This district was in the charge of Maj. C. S. Riché, Corps of Engineers. Division engineer, Col. W. H. Bixby, Corps of Engineers.

1. *Operating snag boats and dredge boats on Illinois and upper Mississippi rivers.*—By the river and harbor act of August 11, 1888, provision was made for securing the uninterrupted work of snag boats and dredge boats on the upper Mississippi River under a permanent appropriation, the sum so expended not to exceed \$25,000 annually.

By river and harbor act of March 2, 1907, the annual appropriation for operating snag boats on the upper Mississippi River was made available for similar purposes on the Illinois River from its mouth to Copperas Creek.

During the past fiscal year the snag boat *David Tipton* (formerly *Colonel A. Mackenzie*) was employed from July 1 to November 2, 1907, and from May 7 to June 30, 1908, in removing snags and other obstructions, and otherwise assisting the interests of navigation in the upper Mississippi River between Minneapolis and the mouth of Missouri River. The Illinois River was not visited by the snag boat during the fiscal year on account of continuous high water in that stream.

The U. S. hydraulic dredge *Neela* was employed September 25 to October 31, 1907, in removing obstructions at the steamboat landing at Keokuk, and from May 1 to 8, 1908, in similar work at Fort Madison.

The *Davis*, hydraulic dredge, hired by the Government, was engaged during a portion of June, 1908, in removing deposits above Moline Lock.

* Deduct \$13.25 expended during the year on account of inspections for the Illiniem Canal Commission, leaving net amount of \$164,457.53 expended upon the improvement.

1614 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Summary of cash expenditures for operating U. S. snag boats H. G. Wright and J. N. Macomb in connection with the work of removing obstructions in Mississippi River, and in the removal of Beaver Dam rock, during the fiscal year ending June 30, 1908.—Continued.

Application.	For fiscal year 1908.						Total.
	Jan.	Feb.	Mar.	Apr.	May.	June	
Office expenses.....	\$762.23	\$8.17	\$1,025.48	\$16.75	.....	\$22.60	\$3,398.71
Expenses of snag boat H. G. Wright:							
Crew.....	2,233.00	2,240.00	2,227.50	2,269.66	\$4,317.67	67.67	26,567.16
Outfit.....	.....	.....	.....	.....	.....	78.62	110.20
Fuel.....	1,112.70	375.97	1,103.99	647.35	855.64	110.15	9,594.23
Subsistence.....	351.94	437.95	316.02	690.83	157.02	101.49	4,851.42
Supplies.....	.....	.....	.....	24.75	.....	434.65	462.70
Repairs.....	262.36	.....	.....	42.00	.....	537.42	1,608.71
Miscellaneous.....	.....	.....	.....	8.39	.....	.....	14.64
Expenses of snag boat J. N. Macomb:							
Crew.....	2,216.00	2,225.00	2,257.25	2,001.92	1,767.43	88.68	25,865.89
Outfit.....	16.50	.....	.....	385.09	37.50	67.42	1,081.28
Fuel.....	617.06	1,219.68	489.65	173.47	182.62	.....	7,624.83
Subsistence.....	718.62	293.78	303.28	392.66	322.67	352.84	5,478.74
Supplies.....	.....	.....	.....	513.41	.....	17.75	569.38
Repairs.....	262.36	.....	17.63	1,724.75	724.73	80.60	3,633.45
Miscellaneous.....	.....	.....	.....	3.35	.....	.....	3.85
Total.....	8,591.67	6,806.45	8,039.70	8,888.28	6,395.03	1,958.09	90,954.68
Removal of Beaver Dam rock:							
Labor.....	.....	.....	.....	.....	.....	.....	4,259.88
Material, etc.....	.....	.....	.....	.....	.....	.....	527.62
Lost property.....	.....	.....	.....	.....	.....	.....	876.81
Use of plant, subsistence, etc.....	.....	.....	.....	.....	.....	.....	1,271.96
Total.....	.....	.....	.....	.....	.....	.....	97,889.35

Recapitulation.

Expenses of office and snag boats:	
Fiscal year 1907 (paid in 1908).....	\$5,048.77
Fiscal year 1908.....	86,305.91
Removal of Beaver Dam rock.....	6,934.07
Total.....	97,889.85

Y 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

PROJECT OF 1881, REVISED IN 1883, 1903, AND 1905.

A concise statement of the project for and history of this work will be found in the Annual Report of the Chief of Engineers for 1906, page 462, as well as on page 2631 of the Report of the Chief of Engineers for 1900.

Reference should be made to the Report of the Chief of Engineers, United States Army, for 1894, pages 1577 et seq., for information relating to the development of the various forms of construction and for a résumé of the various types employed between 1872 and 1894, and to the Reports of the Chief of Engineers, United States Army, for 1895, page 2059; 1896, page 1717; 1897, page 2012; 1898, page 1698; 1900, page 2632, and 1901, page 2169, for minor details as to forms of construction.

Since the adoption of this project work has been done substantially according to the methods referred to above at the following locali-

ties: Mouth Missouri River, Sawyer Bend, St. Louis Harbor, Cahokia Chute, Arsenal Island, Horsetail bar, Carroll Island, Twin Hollows, Pulltight, Beards Island, Chesley Island, Jim Smiths, Sulphur Springs, Foster Island, Lucas, Herculanum, Calico Island, Cornice Island, Forest Home, Osborne Field, Michaels Landing, Rush Tower, Fish Bend, Danby Landing, Ames Island, Rush Towhead, Penitentiary Point, Sycamore Landing, Fort Chartres, Crooks, Turkey Island, Mudd Landing, Moro Island, Ste. Genevieve, Fairy Island, Kaskaskia Island, Horse Island, Chester, Crain Island, Liberty Island, Liberty Bend, Lacours Island, Willard, Hamburg, Devil Island, Minton Point, Cape Girardeau, Commerce Island, Burnham Island, Powers Island, Goose Island, Philadelphia Point, Commercial Point, Prices Landing, Buffalo Island, Dogtooth Bend, Greenleaf Bend, Beechridge, Hurricane Field, Eliza Towhead, Eliza Point, Greenfield Bend, and vicinity of Cairo.

During the fiscal year ending June 30, 1908, work for the permanent improvement of the river has been carried on, as hereinafter described, at James Landing, Crain Island, Willard Landing, Devil Island, and Eliza Towhead. (See Pls. I and II.)

The project adopted for the permanent improvement of the Mississippi River between the mouths of the Ohio and Missouri rivers was approved by the Chief of Engineers, United States Army, March 31, 1881. The estimate of the cost, as revised in 1883, was \$16,397,500. The project was modified by the river and harbor act of June 3, 1896, to permit the construction and operation of dredges. It was again modified to some extent in 1903 by the Board of Engineers for Rivers and Harbors in report dated November 12, 1903, the dredging authorization of which was adopted by Congress in the river and harbor act of March 3, 1905.

The interpretation of this act virtually stopped all construction work for the permanent improvement of the river within the district, except for the small unexpended balances from previous appropriations. Attention being called thereto, an unallotted portion of the appropriation was made available by an act approved June 29, 1906, for the construction of works urgently needed.

By the report of 1903 the cost is increased \$20,000,000 in addition to expenditures already made, provided the projects in force be adhered to throughout. The cash expenditures to December 31, 1903, are considered as approximately the cost of the work up to the date of the report of the Board. They were \$10,476,654.53. The total estimated cost as last revised is therefore \$30,476,654.53.

The total amount appropriated to June 30, 1908, was \$12,904,999.98. Of this amount \$180,000 was allotted by acts and projects for improvement between the Illinois and Missouri rivers, including Alton Harbor, leaving a balance of \$12,724,999.98 to be applied to the project for the general improvement between the mouths of the Ohio and Missouri rivers. The balance of the last revised estimate not appropriated June 30, 1908, is therefore \$17,751,654.55.

WORKS OF IMPROVEMENT.

Because of the small balance of funds available, for the reasons stated, operations for the construction of works of permanent improvement were confined to the repair, maintenance, and completion

of hurdles and revetments already placed under the original project. Three dredges were in commission throughout the fall, operating upon 12 obstructing bars which developed during the low-water season of navigation. The construction of the various parts of the two suction dredges, required by act of Congress approved March 3, 1905, and under contract, was continued, and at the close of the year one dredge had been completed and delivered and fair progress had been made upon the other, so that its delivery, together with that of the ponton and pipe lines for both, is assured not later than August, 1908. The alterations to two older dredges were completed. Such local surveys and examinations were made as were needed. Gauges were maintained and read throughout the year.

The plant was repaired and cared for at the engineer depot, St. Louis, and in the fleets at Claryville, Mo., and Santa Fe, Ill. In the spring the Claryville fleet was abandoned and the vessels there were moved to Santa Fe for economy in their care.

Materials were procured by contract, and by hired labor, as was deemed most economical and advantageous to the United States.

Reports from assistants, giving details and accompanied by charts showing the locations of the various works, are on file.

CONSTRUCTION WORKS.

In the repair, completion, and extension of permanent works for channel regulation and improvement the standard forms of hurdles and revetments were used, consisting, for the former, of permeable dikes of piling driven in one to three rows of 3-pile clumps through wide foundation mattresses woven of willow and cottonwood brush, and for the latter, of similar mattresses placed along caving banks between the low-water contour and the underwater foot of the bank slope, and stone riprap placed above the low-water contour to the bank top, or as high as the proper natural slope (1:2) might have extended.

JAMES LANDING, ILL. (34 MILES BELOW ST. LOUIS).

[Sept. 3–Oct. 18.]

New bank protection.—During the spring and summer of 1907 continuous caving, with a rapid recession of the bank line, occurred between the end of the work of 1906 (James Landing) and the head of the work of 1904 (Osborne Field). In order to check this recession, primarily to protect the work at Osborne Field, Ill., from being outflanked by the river, the work of 1906 was extended downstream to a junction with the work of 1904. Incidentally protection was also given to the Monroe County levee which, at this locality, is in dangerous proximity to the river bank. The work was done during September, October, and November; 3,265 linear feet of brush mattress—100 feet wide—were placed, connecting with the upper end of the mattress at Osborne Field, Ill., and above this mattress the bank was graded and the stonework placed to the 18-foot stage. The bank above the revetment of 1906 having been graded by the river to a slope favorable for the reception of stone, the stonework was raised from the 14-foot contour to the 19-foot throughout, except for 465 linear feet covered with silt.

The extent of the protection now in place at this locality is as follows: 11,200 linear feet of mattress; 500 linear feet of stonework raised to the 16-foot stage; 5,265 feet to the 19-foot stage; 3,335 feet to the 18-foot stage, and at Osborne Field, 1,850 feet to the 11-foot stage, leaving 250 feet still unrevetted with stone. Revetting this small portion of the bank and making the contour of the stonework at Osborne Field uniform throughout has been prevented since the spring of 1905 by a bar along the river front denying approach with materials.

CRAIN ISLAND, MISSOURI (72 MILES BELOW ST. LOUIS).

[July 1-16.]

Repair of hurdle.—A body of drift having collected above hurdle dam No. 1, a mattress 375 feet in length and 33 feet in width was built on top of the drift and the mass was sunk against the dam, adding greatly to the strength of the section repaired during the latter part of the preceding fiscal year.

Bank protection—Repair of revetment.—The sloping spur hurdle, in process of construction at the close of the last fiscal year, was completed, and two others, each 50 feet in length, were built.

The stone revetment, for 900 linear feet (18,780 square feet), was repaired. As the greater part of the repaired work is in the vicinity of the three-spur hurdles, additional security was thus given to their shore ends.

WILLARD LANDING, ILLINOIS (111 MILES BELOW ST. LOUIS)

[July 17-31.]

Repair of hurdle dam.—A large amount of drift having collected above that portion of the hurdle dam repaired during the latter part of the spring season (1907), a mattress, 610 feet long and 35 feet wide, was constructed on the drift and weighted with stone until the accumulation rested on the river bottom.

DEVIL ISLAND, ILLINOIS (120 MILES BELOW ST. LOUIS).

[July 1-31.]

Repair of hurdle dam.—The work of repairing the hurdle dam at the head of the island was in progress at the beginning of the fiscal year, the foundation mattress having been completed across the main break at that time. An apron mattress, 130 feet in length, was constructed and sunk across another much smaller break. The shore end of the hurdle was protected by a mattress 264 feet in length (25,822 square feet), and 5,386 square feet of stonework was placed on the bank above it. Pile driving was begun near the middle of July, and was completed at the end of the month. The reconstructed section of hurdle makes an obtuse angle, upstream, with the old hurdle line. Its length from the nearest point of the Illinois shore is 270 feet.

A section of old piling, 300 feet long, in the body of the hurdle, was strengthened by driving a single row of clumps below it. Another

section, 400 feet long, was reenforced by a row of clumps and single piles driven above it. The original length of hurdle, 1,200 feet, has been increased by reconstruction to 2,000 feet; of this increase, 270 linear feet were built during the fiscal year.

Bank protection—Repair of revetment.—Active caving of the bank of this island at two places near the lower end of the bank protection was causing a recession of the bank and destroying the revetment. In one cave two sloping spur hurdles, 60 and 100 feet in length, respectively, were constructed and 350 linear feet of foundation mattress were placed along the bank; in the other a foundation mattress extending from the present shore line to the old foundation (165 linear feet) was placed, and a sloping spur hurdle 100 feet in length was driven through it.

ELIZA TOWHEAD, ILL. (168 MILES BELOW ST. LOUIS).

[Oct. 19—Dec. 6.]

New bank protection.—For a brief but comprehensive history of this locality and of the previous work done reference is made to the Report of the Chief of Engineers for 1907, page 1646.

Continued and rapid caving caused a further recession of the bank at this locality, with great damage to the work placed in the fall of 1906. Mattresses 100 to 130 feet in width, and in three sections, were constructed, connecting the sections placed in 1906, thus making the mattress work continuous throughout the bank reach protected. The stonework was carried up to the average height of the 13-foot stage (St. Louis gauge) throughout; to attempt a higher contour was not considered advisable at this time on account of the lateness of the season (November) and the excessive amount of earth to be moved before the stone could be placed. It is expected that the next high water will grade the top zone of this bank, at least partially, so that the stonework can be raised to a higher contour with a minimum of effort.

The total linear feet of protected bank is now 3,535 feet. In accomplishing this result 370,925 square feet of mattress and 123,340 square feet of stonework were placed.

DREDGING.

Dredges Nos. 2, 3, and 4 were in commission as follows: No. 2, September 11 to November 30; No. 3, September 3 to December 17, and No. 4, August 14 to December 24, 1907. Throughout this low-water season they were operated where necessary and were withdrawn from service and sent to winter quarters as soon as running ice threatened.

Before placing dredge No. 4 at work in the channel, it was taken to Horsetail bar and its pumps and reconstructed suction heads were given a thorough test in materials ranging from silt to coarse gravel. The results were most satisfactory; during fifty working hours 1,250 cubic yards were moved per dredging hour.

Threatened shoaling on bars to 8-foot depths was anticipated as far as possible by placing dredges at the critical points as soon as

soundings showed that shoaling liable to become obstructive was in progress.

Work was done upon the following bars with most beneficial results: Ames Towhead, Dickoy Field, Little Rock incline, Baumstark, Phillips Landing, Mansker, Anchor Landing, Seventy-Six, Grand Tower Island and Bend, Bainbridge, and Beechridge.

The total number of channels dredged at the 12 localities named was 19, with a combined length of 20,500 feet and an average dredged width of 150 feet.

The dredged channels were in constant use by the river craft after their completion and maintained the 8-foot depth of channel required throughout the district, except for short intervals at several localities, where the depth decreased to 7 feet until a dredge was available for work at each, when the obstructing bar was quickly cut away.

The total amount of material excavated was about 980,000 cubic yards in 1,568 dredging hours, or at the rate of 630 cubic yards per hour.

Fluctuations in the stage of the river caused the shifting of the shoals at Baumstark, Mansker, Bainbridge, and Grand Tower Island Bend, necessitating repetition of dredging at all of them.

Great relief was given at the railway incline at Little Rock, Mo., by dredging the shoal obstructing approach and widening the channel leading thereto.

The dredges were in operation only about one-fourth of their time in commission; but their efficiency per dredging hour as compared with that of the preceding fiscal year has been increased about 25 per cent. This result is due to the installation of the new pumps on Nos. 3 and 4 in conjunction with their reconstructed suction heads and pipe lines. The percentage of increased efficiency would have been higher if the low-pressure engines on dredge No. 4 had not broken down, necessitating their removal and the operation of the dredge for the remainder of the season by its high-pressure cylinders alone.

The final cost of the dredging was about 10½ cents per cubic yard of sand moved, which includes the cost of all idle time of the dredges and their crews and the upkeep and repairs to the former during the entire year.

If the dredges had been run for the entire time in commission, the expense would have been augmented only by the increased amount of fuel, oil, etc., consumed, and the cost for such continuous operation with the same average output would have been reduced to about 4½ cents per cubic yard. As dredges must be held in readiness for work as it offers, and which depends upon the fluctuation in river conditions, such variations in the cost of the work can not be avoided.

PLANT.

The efficiency of the plant was maintained by ordinary or extensive repairs, as were required. No addition was made to the number of vessels in any class of the floating plant. A number of barges are unserviceable without extensive repairs; five are in such poor condition that they have been condemned as unfit for further service or

repair and are advertised to be sold. One dredge has been dismantled on account of the unserviceable condition of its old wooden hull and its small capacity, but its place is taken by a new steel hull dredge of much greater capacity. Six barges were loaned to the Memphis office in September and were retained there during the remainder of the year. Two old pile drivers were sunk and lost at Beaver Dam rock, and two were transferred permanently, together with the steamer *Gen. T. L. Casey*, to the Mississippi River Commission.

Alterations of dredges Nos. 3 and 4.—The alterations on these dredges, begun in the fiscal year 1906-7, were completed in August.

New dredges Nos. 5 and 6.—The contractors for the hulls, boilers, cabins, and propelling machinery of these dredges have made good progress. Dredge No. 5 was delivered at the engineer depot on the 1st of May and the machinery has been since installed, so that this dredge will be available for service on delivery by the contractors of its pontoons and pipe line which are expected in August, when No. 6 will also be delivered and then immediately made ready for service.

Engineer depot, etc.—The shops, buildings, machinery, tools and appliances at the engineer depot and at Little Rock quarry, together with all vessels, other floating plant and their equipment have been kept in order and all ordinary repairs absolutely necessary to maintain their efficiency have been made.

Much plant, tools and appliances, etc., was loaned during the year to the various survey parties operating under the Board on Examination and Survey of the Mississippi River, and under the Mississippi River Commission, and repairs for both of them were made as needed at the shops and yard of the engineer depot.

MATERIALS.

Of the materials required for construction works, 5,122 cubic yards of stone were procured by contract, and 18,787 cubic yards by hired labor at the quarry at Little Rock, Mo., which was in operation from September 5 to December 3, 1907. The brush, 4,010 cords, was procured by hired labor.

PHYSICAL DATA.

The gauges were maintained and read daily throughout the year and their records have been plotted on the hydrograph. During the year the river oscillated between stages 2.3 feet below and 30.9 feet above standard low water (4.0 feet St. Louis gauge).

Surveys were made between Herculaneum and Fort Chartres Landing, Little Rock and Head of Moro Island, Kirk Landing and Head of Liberty Island, Bishop Landing and Red Rock, Bainbridge and Eliza Point.

Money statement.

July 1, 1907, balance unexpended.....	\$577,581.60
Amount appropriated by sundry civil act approved May 27, 1908.....	250,000.00
June 30, 1908, miscellaneous receipts.....	13,593.04
	<hr/>
	841,174.64
June 30, 1908, amount expended during fiscal year:	
For works of improvement.....	\$68,061.21
For maintenance of improvement.....	398,409.57
	<hr/>
	* 464,470.78
July 1, 1908, balance unexpended.....	378,703.86
July 1, 1908, outstanding liabilities.....	21,700.98
	<hr/>
July 1, 1908, balance available.....	354,903.88
July 1, 1908, amount covered by uncompleted contracts.....	68,739.17
Amount (estimated) required for completion of existing project.....	17,751,654.55
	<hr/>
{ Amount that can be profitably expended in fiscal year ending June 30, 1910, for maintenance of improvement in addition to the balance unexpended July 1, 1908.....	250,000.00
{ Submitted in compliance with requirements of sundry civil act of July 4, 1907, and of section 7 of the river and harbor act of 1890.	

APPROPRIATIONS.

June 10, 1872.....	\$100,000.00	June 8, 1896.....	\$275,000.00
March 3, 1873.....	200,000.00	June 4, 1897.....	673,333.33
June 23, 1874.....	200,000.00	July 19, 1897.....	325,000.00
March 3, 1875.....	200,000.00	July 1, 1898.....	673,333.33
August 14, 1876.....	200,000.00	March 3, 1899.....	673,333.33
June 18, 1878.....	240,000.00	June 6, 1900.....	100,000.00
March 3, 1879.....	200,000.00	June 13, 1902.....	650,000.00
June 14, 1880.....	250,000.00	March 3, 1903.....	650,000.00
March 3, 1881.....	600,000.00	April 28, 1904.....	650,000.00
August 2, 1882.....	600,000.00	March 3, 1905.....	650,000.00
July 5, 1884.....	520,000.00	March 2, 1907.....	250,000.00
August 5, 1886.....	375,000.00	May 27, 1908.....	250,000.00
August 11, 1888.....	300,000.00		
September 19, 1890.....	400,000.00		
July 13, 1892.....	525,000.00	Total.....	12,904,900.08
March 3, 1893.....	658,333.33	Other receipts.....	28,005.47
August 18, 1894.....	758,333.33		
March 2, 1895.....	758,333.33		
			<hr/>
			12,933,005.45

CONTRACTS IN FORCE.

Name: Dubuque Boat and Boiler Works.
 Work: Parts of two hydraulic dredges.
 Cost: \$238,000.
 Date: December 26, 1906.
 Date of commencement: Ten days after notice of approval.
 Date of completion: April 30, 1908.
 Date of delivery of first dredge extended for a reasonable time after September 30, 1907, by the Chief of Engineers, U. S. Army.
 Date of delivery of second dredge extended for a reasonable time after April 30, 1908, by the Chief of Engineers, U. S. Army.
 Name: Western Electric Company.
 Work: Engines, dynamos, searchlights, and arc lights for two dredges.
 Cost: \$3,205.
 Date: April 15, 1908.
 Date of commencement: Upon notification that the dredges are ready.
 Date of completion: Within thirty days after notification that the dredges are ready.

* Deduct \$13.25 expended during the year on account of inspections for the Isthmian Canal Commission, leaving net amount of \$464,457.53 expended upon the improvement.