

COMMERCIAL STATISTICS.

Arrivals and departures of steamboats and barges at the port of Saint Louis in 1878.

Rivers, &c.	Arrivals.	Departures.
Upper Mississippi	965	974
Lower Mississippi	737	760
Illinois	263	265
Missouri	160	171
Ohio, Cumberland, and Tennessee	197	178
Total steamers	2,322	2,348
Barges and canal-boats	1,291
Tons of freight received		714,700
Tons of freight shipped		614,675

Statement showing the amount of freight in tons received and shipped at Saint Louis in 1878.

Rivers.	Received.	Shipped.
	Tons.	Tons.
Upper Mississippi	174,065	67,320
Lower Mississippi	174,181	434,490
Illinois	124,785	18,300
Missouri	56,040	22,465
Ohio, Cumberland, and Tennessee	185,630	72,100

The Illinois River is in the custom district of New Orleans; the length of section under improvement is 223 miles; the enrolled tonnage of vessels on the river, aggregates about 20,000 tons.

SPECIAL REPORT ON IMPROVEMENT OF ILLINOIS RIVER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., August 30, 1878.

GENERAL: In accordance with instructions contained in department letter dated July 16, 1878, having in view the preparation of a plan for the "permanent and radical improvement" of the Illinois River, I have the honor to submit the following "history of the improvement from its inception to the present time, showing what general plan has been adopted, and how far the expenditures have been applied toward carrying out that plan; what changes, if any, have been rendered necessary during the progress of the work," &c.

The records at my command furnish no connected history antedating 1866. They indicate a survey, and report thereon, by Capt. Howard Stansbury, Topographical Engineers, in 1838, but the first step toward the improvement of the river seems to have been under the act approve August 30, 1852, appropriating \$30,000 "for the improvement of the navigation of the Illinois River." It appears that operations to this end, by dredging, were carried on under the directions of Col. J. E. Johnston, Topographical Engineers, but I am unable to state the extent of these operations, or give the localities and dimensions of improved channels. A tabular statement, prepared by Mr. S. T. Abert, civil engineer, and published with General J. H. Wilson's report on the survey of the Illinois in 1866, contrasts low-water depths on certain bars, as shown by surveys in 1838 and 1866. He concludes that this "tabular statement indicates an improvement in depth at many places," and this increased

depth is supposed to have resulted from the dredging done under the appropriation above referred to, from 1852 to 1854, probably. More accurate surveys, in 1867 and subsequently, fail to confirm the deductions drawn from this tabular statement, and I find no sufficient data to show a permanent improvement as the result of this early dredging.

In accordance with the act of Congress approved June 23, 1866, a survey "from the mouth of the Illinois river to La Salle" was ordered. The survey was conducted under the directions of General J. H. Wilson, Mr. S. T. Abert, civil engineer, being in immediate charge. The object of this survey, as stated in General Wilson's instructions to his assistant, was—

To obtain such specific and accurate information in regard to obstructions to navigation in that river as will enable you to submit estimates for its improvement, so that the largest boats navigating the Illinois and Michigan canal and steamboats drawing 4 feet of water will be enabled to pass through the river to Saint Louis during the season of extreme low-water without breaking cargo.

Field operations were commenced at La Salle October 1, and finished at Grafton, the mouth of the river, November 28, the distance being 224 miles. Based upon this survey, the estimate for dredging channels through shoals and bars, so as to give a width of 150 feet 5 feet deep at extreme low-water was 1,234,605 cubic yards, at a total cost \$1,528,450, or about \$1.24 per cubic yard. General Wilson considered that this plan of improvement was applicable "to a part of this river only"; that it "cannot be depended upon to give more than 4 feet navigation under the most favorable circumstances," and recommended "the improvement of the Illinois River by a system of locks and dams, to be placed at such points between Lockport and Grafton as may be determined, after a full and careful survey, to be most advantageous; and that navigation shall be extended to the harbor of Chicago by the enlargement of the Illinois and Michigan Canal so as to adapt it to the use of the largest boats plying on the Mississippi River." His project contemplated a navigable depth of 7 feet through canal and river at extreme low-water; the locks to be 350 feet long and 75 feet wide. The total cost was approximately estimated at \$21,373,906, of which amount \$3,123,796 applied to the improvement of the river, the balance to the enlargement of the canal. As a preliminary to the commencement of the work, a detailed and careful survey was recommended. (For further details, arguments in favor of this project, &c., see General Wilson's report, House Ex. Doc. No. 16, Fortieth Congress, first session.)

The act approved March 2, 1867, directed the continuation of the "survey of the Illinois River in accordance with the recommendation of General J. H. Wilson." On the 8th of May orders were issued from the Engineer Department constituting General J. H. Wilson and Mr. William Gooding, United States civil engineer, a Board of Engineers, for the purpose of "conducting surveys and examinations and preparing plans and estimates for a system of navigation by way of the Illinois River between the Mississippi and Lake Michigan, adapted to military, naval, and commercial purposes." To carry on this work, three parties were successively organized; the first two, commencing work in June and July, were occupied between Chicago and La Salle, to determine questions pertaining to the enlargement of the canal and the most feasible route from the river to the lake. The third party was organized "late in August, the Illinois River having reached the lowest stage known for years"; this party was specially charged with the low-water survey, directed to survey "the bed of the river, and particularly the sand-bars below La Salle."

Field operations on these surveys were continued throughout the fall of 1867. The board submitted its report December 17, 1867. (Report Chief of Engineers for 1868, p. 438.) The Board concluded, after a careful examination of all the facts developed by extensive surveys and personal examination, that, "in constructing such a system of navigation as the interests of the country require, the government must follow the general line of the Illinois and Michigan Canal and the Illinois River"; and the opinion was expressed that the line recommended "is the only feasible route for deep-water communication between the great lakes and the Mississippi River equally adapted to military, naval, and commercial purposes." The *plan of improvement* recommended by the Board was to create slackwater in the Illinois River from near its mouth up to the head of Lake Joliet (passing the "Grand Rapids" at Marseilles by a piece of independent canal), securing a navigable depth of 7 feet at the lowest known stage of the river; this improvement of the river proper, to be supplemented by the enlargement of the Illinois and Michigan Canal to a corresponding capacity. The estimated cost of the entire improvement was \$18,217,242.56, of which amount less than two million dollars applied to the *river* improvement from its mouth to La Salle. It was recommended that this part of the work should be done first, and the principal elements in its accomplishment were the construction of five locks and dams, as follows:

	Estimated cost.	
	Lock.	Dam.
Near Henry.....	\$240,000	\$80,000
Near Copperas Creek.....	240,000	58,500
Near La Grange.....	235,000	61,500
Near Bedford.....	240,000	90,000
Near Six-Mile Island.....	330,000	195,000
Total cost.....	1,285,000	485,000

With reference to other plans of improvement, the board considered that while the navigation of the river might be much improved by *dredging* and wing-dams, it was "doubtful whether any amount of expenditure upon this plan would give an available depth for navigation of more than 4 feet at extreme low-water in a channel 160 feet wide," and that "such an improvement, if it could be made permanent (of which we have great doubt), would certainly fail to meet the military, naval, and commercial purposes designed," &c. The plan of supplying water from Lake Michigan to maintain sufficient depth during the low-water season was rejected by the board as "impracticable at any cost."

The report gives in considerable detail the naval and military considerations in favor of the improvement, the advantages of the Illinois and Michigan Canal as the connecting link between the river and lake, the objections to other lines that had been suggested, and arguments in favor of the lock-and-dam system on the river, as well as those against the other systems of improvement considered; but the object of this communication does not call for the repetition of all these points. The report is printed in the Annual Report Chief of Engineers for 1868, pp. 438 to 468.

In the following year field operations were confined to special examinations and local surveys for the selection of sites for the contemplated locks and dams. These examinations were not sufficiently thorough to

absolutely fix upon the sites, but they indicated that the natural features of the localities examined would present no great obstacle to the construction of the required works nor to their subsequent security. The manner of conducting these examinations, together with the descriptions of the several sites, is published in the Report of the Chief of Engineers for 1869, pages 252 to 259.

In the mean time \$85,000 had been allotted to the Illinois River from the general appropriation for \$1,500,000 (act approved July 25, 1868), to be applied to the improvement of the river from La Salle to its mouth. This amount being too small to begin with, it was subsequently withdrawn (no expenditure having been made therefrom), and it was recommended that no work on the contemplated plan should be undertaken until \$300,000, estimated as the amount required to complete one lock and dam, had been appropriated. This amount was asked for for the fiscal year ending June 30, 1869, but it was not appropriated. The general assembly of the State of Illinois, however, looking to the accomplishment of the proposed plan of improvement, directed the construction of a lock and dam (at Henry) as the first step in the work (act approved February 26, 1869). Operations on this work were carried on under the directions of the State board of canal commissioners, in substantial conformity to the plan of improvement recommended by the United States Board of Engineers.

From the general appropriation of \$2,000,000 (act of Congress approved April 10, 1869), \$84,150 was allotted for improving the Illinois River. It was decided to apply this toward dredging the bars between Henry and the site of the next proposed dam (at or near Copperas Creek), so as to give 7 feet depth, with less height of dam at the latter place. In recommending this application of the funds, General Wilson states:

Former dredgings on this river by the government (in 1859) have demonstrated the fact that permanent improvements can be effected by this method.

Work under this project was commenced October 28, 1869.

In the following year (1870) General Wilson directed a change in the plan of operations, so as "better to subserve the interests of navigation." His modified plan proposed that the funds should be applied to dredging an open channel 150 feet wide and 4 feet deep at low-water, and to building "catchment and wing-dams," where necessary. Those bars which formed the greatest obstruction to navigation were to be dredged first, and it was proposed to continue in this way "until the means for slack-water navigation are fully or nearly furnished." From that time to the present, all dredging operations have been substantially in accordance with this plan, except that in many cases the channels were not dredged to the full width contemplated.

In the fall of 1870, Col. J. N. Macomb, Corps of Engineers, succeeded General J. H. Wilson in charge of this work. Under his directions a revised estimate of the cost of dredging the channels (150 feet wide, 4 feet deep) and building the auxiliary dams was prepared, amounting in round numbers to \$392,000, provided money sufficient to complete the work in two years should be appropriated. The estimated cost of subsequent maintenance was \$20,000 for building dredging machinery, boats, &c., to be operated by hired labor; the annual running expenses being estimated at \$8,000. (Report Chief of Engineers for 1871, pages 279 and 280.)

During the period that Colonel Macomb was in charge of the work (1870 to 1877), operations were continued by dredging, building dams, &c., at points where the interests of navigation called for work, all on the general plan adopted in 1870.

The annual report for 1873 (page 437) states that the—

Improvement has thus far been carried on conjointly by the general government and the State of Illinois, according to a system adopted some four years since; the State of Illinois undertaking the building of locks and dams, and the United States preparing the river bed so as to afford, when the dams shall have been built, a navigation for vessels drawing 7 feet of water. To complete the last-named part of the work will probably require about \$350,000. * * *

In the mean time the State had built a fine lock and dam at Henry, while the general government had "prepared the river bed" from that place to Copperas Creek, in the vicinity of which a second lock and dam were to be built.

In 1873 some arrangement was made by which the government undertook to build the foundations of the Copperas Creek lock, at a cost of about \$80,000; the State was to complete the lock and build the dam. Operations on the lock-pit were commenced by the government September 1, 1873, and continued until the end of September, 1874, when the foundations were finished, the work turned over to the State, and has since then been completed. In the fall of 1877 Capt. G. J. Lydecker, Corps of Engineers, was assigned to the charge of the work, relieving Col. J. N. Macomb, and dredging operations, under the contract then in force, were continued to the end of the last fiscal year (June 30, 1878), when the contract was closed; since that date no work has been done.

The extent to which navigation has been improved may be briefly stated as follows: The State works at Henry and Copperas Creek furnish a reliable 7-foot navigation for a distance of about 100 miles. On that part of the river below Copperas Creek a present navigable depth of 4 feet has been obtained over the worst bars by dredging, building wing-dams, &c., but other bars remaining unimproved will not carry more than 2½ feet during extreme low-water; consequently through navigation is limited to that depth during low-water season.

All work on the river has been done by contract. Its extent and the amount paid therefor to contractors may be summarized as follows: (For details, see Statement A.)

(a) Total dredging, 811,434 cubic yards	\$235,785 39
(b) Time work by dredge (snagging, &c.), 1,655 hours	17,050 77
(c) Brush and stone dams, about 6,000 linear feet	29,117 08
(d) Foundation Copperas Creek lock	62,358 90
(e) Removing wreck near Peru	450 00
Total paid to contractors	344,762 14

The aggregate length of dredged channels is 123,320 linear feet, varying in width from 40 to 150 feet, most of them being under the full width designed. The dredged material was largely used in forming dikes and dams for contracting the river or closing lateral channels, in addition to the brush and stone dams referred to above.

The total amount appropriated for the improvement from 1869 to June 30, 1878 (Statement B, appended), is	\$549,150 00
Amount expended to June 30, 1878 (Statement C, appended), is	471,016 58
Balance available July 1, 1878	78,133 42

The principal facts gleaned from the preceding historical sketch of the improvement may be recapitulated as follows: The *plan of improvement*, adopted by the Board of Engineers after extensive surveys in 1866 and 1867, was a lock and dam (slackwater) system, designed to furnish a reliable 7-foot depth. Appropriations sufficient to carry out this plan were not made, whereupon the State of Illinois undertook the work of building the necessary locks and dams, substantially on the plan adopted by

the board, and up to date have finished two of these works, viz, at Henry and Copperas Creek, the general government building the lock foundation at the latter place. As auxiliary to the State work, the general government commenced (in 1869) dredging channels through the various bars between Henry and Copperas Creek, to a depth sufficient to give 7 feet navigation when the dam at Copperas Creek was finished, intending to continue down the river, and in this way provide for the required depth, with diminished height of dams. This plan was soon modified (in 1870) to dredging channels, 4 feet deep, through the worst bars, taking them in the order of their importance as obstructions to navigation, so as to enlarge the navigability of the river as rapidly as possible. In connection with this work, wing-dams were built, and side channels closed by brush and stone dams, &c. These different changes were "rendered necessary" only because Congress did not appropriate sufficient money at any one time to warrant a start on the plan recommended, while parties interested in the navigation of the river called for immediate relief.

The only work done by the general government, applied to carrying out the plan adopted by the board, was the construction of the Copperas Creek lock foundation, and dredging in the pool above; the total expenditure for these purposes was about \$150,000. All other expenditures, amounting to \$321,016.58, were on the plan of dredging open channels, building wing-dams, &c., to give immediate relief to navigation; hence this may be regarded as the "general plan adopted."

In addition to what precedes, I am called upon to state "whether any material changes are in your (my) judgment necessary, and whether, in any plan for the radical improvement, the work already accomplished may not form a component part."

It is my opinion, for the reasons to be given, that some material changes in the general plan adopted are necessary, in order to accomplish, at an early date, the ultimate object; but that the work already done may form a component part, and aid in the execution of any plan for a more perfect and radical improvement. The objections to the present plan of operations may be stated in general terms as follows: Slow progress towards the attainment of the completed improvement; temporary character and excessive cost of the results obtained. I do not know the nature of the agreement by which the State and general government co-operate in the work; whether it is a well-defined and binding affair, or simply an indefinite understanding. In either case it is one of the principal causes operating to retard the progress of the work. The interests involved in its completion are not local simply, but widespread, and it is my belief that the improvement would be attained more speedily, and the various interests best subserved, if the whole cost and direction of operations for the improvement of the river were assumed by the general government; and it is eminently right that this should be done when the national importance and general commercial value of the route are considered. The State government will have much more than its share of the expenses if it enlarges the Illinois and Michigan Canal to give to the through line the width and depth designed; the estimated cost of this part of the work being about \$16,250,000. If the ultimate improvement is to be obtained by carrying out the slack-water system, it would be far better to build the necessary locks and dams *at once*, and not do any more dredging in the pools resulting from their construction until they are completed; afterwards, this dredging could be done where needed, at less expense, and the work would be permanent, or as nearly so as possible. On this plan we can

speedily, *economically*, and *surely* secure the radical improvement desired; one which would furnish a certain and reliable navigation at all times, for vessels drawing 6 feet; and if the necessary appropriation can be obtained, I would urge its adoption as the basis for next season's operations. The work already done will modify in some of its details the project proposed by the Board of Engineers. Without going extensively into these details here, it may be sufficient to state that instead of three more locks and dams, it is my opinion that only two will be necessary, the last dam on the river being located in the vicinity of Columbiana Flats, about 31 miles above the mouth of the river. The fall of the river in these 31 miles (as shown by profile of 1867) is 3 feet, or only 0.1 foot per mile. The depth of water is considerably over 7 feet for most of the distance, and but little dredging would be required to give this depth throughout, while the conditions are such that channels of any desired width could be made, and they would be permanent. The total cost to complete, by this system, should not exceed \$1,000,000.

Whatever dredging is necessary should be done by machinery owned and operated by the government. My annual report for 1878 contains this recommendation and the reasons therefor. I may add to what is stated therein, that from an examination of the statements accompanying this report, it would appear that the average cost of dredging, including the elaborate surveys and engineering operations necessary in following out the contract system heretofore in use, was over 40 cents per cubic yard. I would also note that my predecessors in charge of the work have, on different occasions, recommended the purchase or construction of a dredging outfit, to be operated by the government.

The question as to what is our best course, if we cannot have the means to build the locks and dams, remains to be answered. In this case we should prepare for obtaining the best practicable improvement by dredging, and the construction of wing-dams and dikes. It is impossible to state positively to what extent the river may be improved by this method, though I should look for something much better than a channel 160 feet wide and 4 feet deep, the limits indicated in the report of the Board; but it must be remembered that the board had under consideration the whole length of river, up to La Salle, while we have now in question only that part from Copperas Creek lock to the mouth, where the slope is less than on the upper section, and the low-water discharge is considerably greater. The distance from the lock to Grafton is 137 miles, with a total fall (low-water surface, profile of 1867) of 21 feet, giving a mean fall of 0.15 foot per mile; the aggregate lengths of bars and shoals on which the depth at low-water is less than 6 feet is about 70 miles, or a little more than one-half the entire distance. It is unfortunate that the surveys and records thereof, at least such as are accessible to me, do not supply all the data required for a complete discussion of the questions before us; they furnish everything necessary to show that a slack-water system can be readily and cheaply obtained, but little that is required for a careful consideration of other methods of improvement. For that now under consideration we should know with some certainty the low-water discharge at different places on this section of the river; but from the records in my possession, I can find no reliable information on this point, and I have been unable to have it determined, for the reason that no low-water stage has been reached since my connection with the work began. From such facts as I have been able to gather, it cannot be assumed as exceeding 2,000 cubic feet per second. A channel 200 feet wide and 6 feet deep, with a slope of

0.2 foot per mile, would discharge *1,548 cubic feet per second, whence it is to be inferred that such a channel could be made and maintained through the different bars, if the low-water cross-sections outside of the channel limits are properly reduced by low dams. The amount of dredging would be very great, not short of 8,000,000 cubic yards probably; with suitable machinery and systematic work (*i. e.*, completing each channel before commencing on another, instead of moving from place to place simply to supply the present wants of navigation), it could be done at 15 cents per cubic yard; but even at this rate the first cost of the dredging would be \$1,200,000; the auxiliary wing-dams would cost at least \$50,000 more, and the subsequent annual cost of maintaining the improvement could not safely be estimated at less than \$15,000. It is possible that the amount of dredging might be diminished by an increased expenditure for dams and dikes, but at present I have no data to show that any saving in cost could be effected in this way, and it is not believed that the construction of channels materially smaller than the one indicated would meet the ultimate requirements of the route. The time in which the improvement could be accomplished on this plan cannot be stated definitely, nor can any positive statement be made as to its permanence. It is highly probable, however, that most of the work would stand well, deteriorating slowly and gradually; but in some localities it would be liable to sudden and complete destruction at any time.

Comparing, now, this with the slack-water system, it is seen that the latter has the advantage in every important feature. It will cost less, can be accomplished within a shorter period of time, its results would be certain, and the improvement would be permanent. It may be proper to note here that those at present interested in the local navigation of this part of the river seem strongly opposed to the slack-water system, and really look upon the structures at Copperas Creek and Henry as obstructions to navigation. The point is, their boats are adapted to a low-water navigation, and they would prefer an open channel of 4 feet rather than have the additional depth and pay the tolls now exacted for the passage of the locks, the owners of boats and barges claiming that these tolls are excessively high, constituting almost a prohibitory tariff on their business. If, however, the construction of the remaining locks should be undertaken by the general government, there would be a decided change in this respect; the tolls then collected being reduced to the amount necessary for maintaining and operating these works only would be a small matter, and would cause no complaint, when the great advantages to be derived from the improvement are recognized. But as it is now, the locks on the river are under the same management as the Illinois and Michigan Canal, and the tolls from the former are undoubtedly applied, in part, at least, to maintain the latter. It would seem

*By de Prony's formula:

$$V = 100 \sqrt{K 1 - 0.15'} = 1.41 \text{ feet,} \\ \text{whence discharge} = 1,692 \text{ cubic feet.}$$

By Eytelwein's formula:

$$V = 94.5 \sqrt{K 1 - 0.11'} = 1.27 \text{ feet,} \\ \text{whence discharge} = 1,524 \text{ cubic feet.}$$

By Bazin's (river) formula:

$$V = \sqrt{\frac{R^m I}{0.00028 \left(1 + \frac{1.25}{R^m}\right)}} = 1.19 \text{ feet,} \\ \text{whence discharge} = 1,428 \text{ cubic feet}$$

The mean (1,548 cubic feet) is taken above.