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51ST CONGRESS, 1st Session. } HOUSE OF REPRESENTATIVES. { Ex. DOC. No. 264.

SURVEY OF WATER-WAY FROM LAKE MICHIGAN TO THE ILLINOIS RIVER.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

A letter from the Chief of Engineers, with a copy of a report from an officer of the Corps of Engineers upon the survey of a water-way from Lake Michigan to the Illinois River.

MARCH 11, 1890.—Referred to the Committee on Rivers and Harbors.

WAR DEPARTMENT,
Washington, March 11, 1890.

The Secretary of War has the honor to transmit to the House of Representatives, in compliance with the provisions of the river and harbor act of August 11, 1888, a letter from the Chief of Engineers, dated the 10th instant, with a copy of the report of Capt. W. L. Marshall, Corps of Engineers, dated the 28th ultimo, upon the survey of a water-way from Lake Michigan to the Illinois River, at La Salle, Ill.

REDFIELD PROCTOR,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 10, 1890.

SIR: In the river and harbor act of August 11, 1888, Congress, in the item making appropriation for the improvement of the Illinois River, provided as follows:

And for the purpose of securing a continuous navigable water-way between Lake Michigan and the Mississippi River, having capacity and facilities adequate for the passage of the largest Mississippi River steam-boats, and of naval vessels suitable for defense in time of war, the Secretary of War is authorized and directed to cause to be made the proper surveys, plans, and estimates for a channel improvement and locks and dams in the beds of the Illinois and Des Plaines rivers from La Salle to Lockport, so as to provide a navigable water-way not less than one hundred and sixty

feet wide and not less than fourteen feet deep, and to have surveyed and located a channel from Lockport to Lake Michigan, at or near the city of Chicago, such channel to be suitable for the purposes aforesaid; the necessary expenses of such surveys estimates, plans, and location to be paid out of the sum herein appropriated for the improvement of the Illinois River.

The duty imposed by the above provision of law was assigned to Capt. W. L. Marshall, Corps of Engineers, the officer in charge of the improvement of the Illinois River, and the field and office work necessary to the preparation of plans and estimates were prosecuted as rapidly as circumstances permitted. I have now the honor to submit the accompanying copy of Captain Marshall's report, dated February 28, 1890, giving results of the survey as required by the act.

Estimates are presented by Captain Marshall as follows:

For the 14-foot project:	
Via Chicago route	$48,282,763
Via Sag or Calumet River route	46,094,213
For the 8-foot project:	
Via Chicago route	26,883,153
Via Sag or Calumet River route	23,885,400

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

SURVEY OF WATER-WAY FROM LAKE MICHIGAN TO THE ILLINOIS RIVER AT LA SALLE, ILLINOIS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., February 28, 1890.

GENERAL: I have the honor to submit the following report upon a survey of a water-way from Lake Michigan to the Illinois River at La Salle, Ill., forming part of a through route of transportation from Lake Michigan to the Mississippi River, required by act of Congress of August 11, 1888.

The act in question is entitled "An act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," and the items directing the survey, plans and estimates, and relating thereto, are as follows:

Improving Illinois River, Illinois: Continuing improvement, two hundred thousand dollars. And for the purpose of securing a continuous navigable water-way between Lake Michigan and the Mississippi River, having capacity and facilities adequate for the passage of the largest Mississippi River steam-boats, and of naval vessels suitable for defense in time of war, the Secretary of War is authorized and directed to cause to be made the proper surveys, plans, and estimates for a channel improvement and locks and dams in the beds of the Illinois and Des Plaines Rivers from La Salle to Lockport, so as to provide a navigable water-way, not less than one hundred and sixty feet wide, and not less than fourteen feet deep, and to have surveyed and located a channel from Lockport to Lake Michigan, at or near the city of Chicago, such channel to be suitable for the purposes aforesaid; the necessary expenses of such surveys, estimates, plans and location to be paid for out of the sum herein appropriated for the improvement of the Illinois River.

In compliance with the orders of the Chief of Engineers a project for this survey was submitted September 21, 1888, which was approved September 25, 1888. The expenses of the survey to be paid from an allotment of $25,000 from the appropriation for the improvement of the Illinois River.

A letter of instructions was received from the Chief of Engineers, dated August 27, 1888, a copy of which is herewith, directing that whatever line might be found most advantageous and economical to the United States, and best suited to subserve the ends in view, that plans and estimates in any event should be submitted for a route terminating within the (then) limits of the city of Chicago sufficiently distinct and in detail to enable the Chief of Engineers to form a definite and conclusive opinion as to its merits regarded from the stand-point of the commercial and sanitary interests of Chicago.

In accordance with the approved project, and with the instructions received, a survey party was organized and put into the field October 1, 1888, under directions of Assistant Engineer L. L. Wheeler, a gentleman of many years' experience of that character in the Government service, and by the close of the season, December 1, 1888, the field-work relating to the superficial survey of the various practicable routes from Lake Michigan, at or near Chicago, via the Chicago Divide and the Des Plaines River Valley, as far as Joliet, Ill., were practically completed. From Joliet to La Salle a survey was made under direction of Maj. W. H. H. Benyaurd, Corps of Engineers, U. S. Army, by Assistant Engineer George Y. Wisner, in 1883, and to avoid unnecessary duplication of work and expense this survey was adopted, as far as it was found sufficient for the purpose, for the basis of the estimates herewith, for that part of the route covered by it.

The most practicable routes across the Chicago Divide, and which have been long known and recognized, are two, each of which admits choice of location, the valleys being quite wide.

(1) By way of the Chicago River and its South Fork, and the present location of the Illinois and Michigan Canal, or Mud Lake and the Ogden Ditch, to the Des Plaines, near Summit, about 12 miles from the City Hall of Chicago, and about 8 miles from Bridgeport; thence via the Des Plaines River Valley, uniting at Sag Bridge with route.

(2) Which is via the Grand and Little Calumet Rivers to Blue Island, thence westward along the old Calumet Feeder Route to the Des Plaines River at Sag Bridge.

There is a practicable detour from the second route which leaves the old Feeder Line a short distance west of Blue Island, and passes in a more direct line south of Lane's Island, and uniting again with the Feeder Line, about 5 miles east of Sag Bridge. Both routes were examined.

The maps of the survey of 1883 being found deficient in the vicinity of Joliet, Treat's Island, and Marseilles, and with respect to the nature of the material of the beds of the rivers Des Plaines and Illinois, and high water levels, additional surveys were made during the year 1889 to supply this information.

Early in the progress of the survey it was discovered that previous report and profiles relating to the subsurface material to be encountered in any deep cut across the Chicago Divide were probably erroneous, and authority was asked by me and received from the Chief of Engineers to have elaborate borings made by competent well-borers, and suitable machinery, to determine the nature of the substrata along the proposed routes.

Proposals were sought from experienced contractors by circular letter, and an agreement entered into December 19, 1888, with Josiah Stevens & Co., of Elgin, Ill., the lowest responsible bidders for the borings along the two routes from Sag Bridge to Lake Michigan. A subsequent agreement was entered into with the same parties dated

May 24, 1889, to extend the borings from the mouth of the Kankakee to Marseilles.

Work under the first agreement began December 19, 1888, and was prosecuted continuously under the two agreements from that date, under many disadvantages, until August 22, 1889, when the last boring above Marseilles was completed. In addition to the borings made in the bed of the Illinois under contract, a special party extended the sub surface soundings below the bed of the rivers in Lake Joliet, Treat's Island, and below Marseilles. The results of these borings appear upon the maps and profiles herewith, and tabulated statements of the material encountered in each boring are hereto appended.

May 1, 1889, the maps of the surveys of the routes across the Chicago Divide having progressed sufficiently to allow estimates of quantities of material along these portions of the routes surveyed to be begun, instructions were requested from the Department as to whether the estimates demanded by Congress should be rendered on the basis of the requirements of navigation for the best channel for navigation, or whether local sanitary questions should also be considered, or estimates submitted under each condition. Copies of the correspondence and instructions received with reference to this subject are hereto appended.

The plans and estimates herewith submitted are upon the basis indicated by the Chief of Engineers, *i. e.*, for a channel not less than 14 feet in depth and not less than 160 feet wide, as required by the act, and also for a channel 8 feet deep and 160 feet in width, as required by the interests of navigation, both channels from Lake Michigan to La Salle.

As pointed out by General O. M. Poe, engineer officer northwest division, in his indorsement on the above-mentioned request for instructions, the act in question is inconsistent in its requirements, and to properly comply with it demands an investigation as to what dimensions of channel are "adequate for the passage of the largest Mississippi River steam-boats, and of naval vessels suitable for defense in time of war."

If the "adequate" channel be found to be less than 14 feet the act would seem to require different dimensions in different parts of the route, *i. e.*, a channel not less than 14 feet in depth and not less than 160 feet in width from La Salle to Lockport, while from Lockport across the Chicago Divide to Lake Michigan, as well as throughout the remainder of the route to the Mississippi River, the channel need be only adequate for the passage of the largest Mississippi River steam-boats that reach it during ordinary seasons of navigation.

Under this view of the act in question we would have a section of 68 miles of navigation 14 feet or more in depth, sandwiched between two inferior channels. It seems evident, however, that Congress intended to direct estimates and plans for the least expensive plan that would meet the requirements of navigation, both commercial and naval, as it exists upon Western rivers, and in case that this channel should be found less than 14 feet deep, estimates should be submitted in any event upon the 14-foot basis throughout the line. The estimates presented herewith, it is believed, will meet any interpretation of the act, and every interpretation that can be made of it. No channel less than 8 feet in depth at low water in Lake Michigan, across the Chicago Divide, or nearly 10 feet deep at mean stages, would probably be considered as meeting the conditions of the act, and certainly no channel as great as 14 feet in depth would be seriously proposed by any one considering only the requirements of Western steam-boats. Any chan-

nel ultimately adopted will doubtless lie between these limits, and the probable ultimate cost thereof be not less than the estimate for the 8-foot channel, nor greater than for the 14-foot channel.

FACILITIES ADEQUATE FOR THE PASSAGE OF THE LARGEST MISSISSIPPI RIVER STEAM-BOATS.

In order to explain the plans and estimates now reported, and to comply as far as practicable with the act of Congress, of August 11, 1888, it is necessary to analyze the navigation of the Mississippi River and its tributaries that must be subserved by this proposed water-way. At the outset it may be said that it is unnecessary to discuss the naval and military requirements of the United States as far as this navigable channel is concerned, separate from the commercial and civil.

All boats navigating the Western rivers must meet the conditions that exist in these streams, and naval vessels, to be at all times serviceable, must be built in accordance with the principles that experience of many years has shown to be necessary for success in the construction of commercial vessels. Any channel that will accommodate the largest commercial vessels that can and do reach the mouth of the Illinois will also accommodate any naval vessel that will probably ever patrol the Upper Mississippi River.

The least of the two channels estimated for from Lake Michigan to La Salle is 8 feet in depth below the lowest recorded stage of water in Lake Michigan and the same depth below the crests of the dams at extreme low water in the Illinois and Des Plaines rivers. This least depth of 8 feet corresponds to a depth of nearly 10 feet (9 feet 10 inches) across the Chicago Divide, at the mean level of Lake Michigan, and 8 feet below the crests of the dams in the river portions of the route, no slope being allowed for. In the canals throughout the line, by filling the levels, a depth of nearly 10 feet can be carried whenever that depth exists in the rivers. These canals, by simply raising the embankments and lock-walls, can be increased to 12 feet depth at small additional expense.

In the Des Plaines and Illinois rivers the practical depth of navigation after the construction of this channel will vary with the stage of the rivers. Reckoning only to the mid-stage, which is about 2½ feet above low water from Joliet to the mouth of the Kankakee and about 8 feet above low water thence to La Salle (except at Marseilles, where it is 4 feet above the crest of the dam), there will be in the river portions of the route from Joliet to La Salle a navigable channel varying in depth from 8 feet, when the discharge of the river is a minimum, to from 10 to 16 feet at mid-stages.

Below La Salle to the Mississippi River, upon the completion of the project now in course of construction and nearly completed, a depth of navigation varying from 7 feet at extreme low water to 12 feet at mid-stage and 18 feet or more at floods will be available. The gauge readings for several years, taken at Copperas Creek below the dam and at La Grange Locks, are herewith, and show how seldom and for what very short periods of time the minimum depth of 7 feet may be expected; the low-water levels having been attained but once since 1879, and then for but a few days.

On the Lower Illinois three out of the four locks and dams are in use, viz, Henry, Copperas Creek, and La Grange. The fourth lock and dam at Kampsville requires a further expenditure of about $125,000 to open

to navigation, and an estimated amount of dredging costing $300,000 throughout the pools to complete the project.

On the Mississippi River the United States Government is laboring under annual appropriations to attain a minimum depth at low water of 10 feet from Cairo to the Gulf, 8 feet from Cairo to St. Louis, and 6 feet on the Upper Mississippi. Whether these minimum depths will ever be obtained and securely maintained is a matter for the distant future to reveal. It is a difficult undertaking as long as sand comes from the Missouri and the Mississippi caves its banks.

The existing minimum depths are from 18 inches to 3 feet or more, less than the ultimate depths sought. The minimum low-water depths sought on the Illinois River are then greater than proposed for that portion of the Mississippi River with which it immediately connects.

A complete list of all steam-boats of more than 50 tons register navigating the Mississippi River and its tributaries, giving the dimensions of their hulls, names, and tonnage, is herewith. This list is intended to embrace every steam-boat so called exceeding 50 tons register that is contained in the last published (for the fiscal year ending June 30, 1888) list of "steam merchant vessels of the United States," issued by the United States Government, navigating the Mississippi system of rivers from the Gulf of Mexico to their heads of navigation, and includes all steam-boats that at that time could have use for the proposed water-way. In this list there are but three with a greater depth of hold than 9 feet. All of these have since been lost or broken up. Whether they have been replaced by similar boats is unknown.

They were large carriers of cotton, built especially for the superior navigation of the lower third of the Mississippi River, and of such width over their paddle-boxes (exceeding 75 feet) that they could not pass any of the locks built by the United States Government or by the State of Illinois upon the Illinois River below La Salle. Even these exceptionally large boats, probably as large as any steam-boat navigating any non-tidal river on the globe drew light with fuel aboard, from 5 to 6 feet only, and as far as mere depth of navigation is concerned, could pass from the Mississippi River to the Great Lakes through the lesser of the proposed channels at mean stage of water in Lake Michigan and the rivers with very large loads of freight, though not with extreme loads. In addition to these "largest Mississippi River steam-boats," which no longer exist, of greater depth of hold than 9 feet, there appears upon the list fourteen steam-boats of between 8 and 9 feet depth of hold. All these boats are built for special routes; navigating the Mississippi and Ohio Rivers below St. Louis and Cincinnati at good navigable stages of water. At low stages all of the Ohio River boats and a large part of the others are withdrawn and replaced with lighter-draught boats. Those that remain go dragging along over sand-bars, at least above Cairo, with half or no loads.

At all stages of water when this class of boats can reach the mouth of the Illinois River they can probably go on through the proposed channel to Lake Michigan, as far as depth of water is concerned, with their full average, but not extreme, loads of freight; but some of them are too wide over all to pass the Illinois River locks below La Salle, their dimensions over paddle-boxes for the most part being adapted to the Louisville and Portland locks, which are 80 feet wide, instead of 75 feet, as on the Illinois River. At what stage in the Mississippi River it is practicable for these boats to reach with their extreme draught of 9 to 10 feet or more the mouth of the Illinois can not be predicted. The bottom of the Mississippi, especially below the mouth of

the Missouri, is unstable, due to shifting sands. Upon any rise and consequent irregular increase of width and capacity of channel at different points the low-water channels in wide places are more or less filled up with sand, and it has been observed, as may be seen from nearly any list of reported soundings, that it is not uncommon to find as deep water at lower stages over obstructed reaches as at higher stages; but the Lower Illinois having a more stable bottom, must, after improvement, be about 5 feet above low water, corresponding to a depth of a little more than 2 feet over the crests of the dams, to allow such boats to go through drawing 9 feet, and the part of the route from La Salle to Lake Michigan—the lake being at its mean level—must have little more than 1 foot of water flowing over the crests of the dams, with the canal levels at Marseilles, Joliet, and above correspondingly filled. This filling is a matter of a few minutes, and it is believed that there will always be more than 1 foot of water over the crests of the dams whenever such boats can reach the mouth of the Illinois. If not, movable crests are very simple devices, commonly used to temporarily increase the height of dams.

The Anchor Line steamer *City of St. Louis* may be taken as a type of the "largest Mississippi steam-boats" since the loss of the great cotton carriers. She is 300 in feet in length and 85 feet over her paddle-boxes. No other steam-boat so wide has been found by this investigation. She can not reach the terminus of the proposed channel at La Salle through the locks on the Lower Illinois, which are, however, of sufficient length to accommodate boats 325 feet long over all, nor can such boats or two boats exceeding 73 to 75 feet in width pass each other safely in a rock-bound channel 160 feet wide, the width of the proposed cut across the Chicago Divide.

The third class of steam-boats in the lists hereto appended, 712 in number, embraces all steam-boats of less than 8 feet depth of hold. The lesser of the channels estimated for will accommodate, as far as depth of water is concerned, at the lowest stages, all of this class, which includes 88 per cent. of the steam tonnage and 97.8 per cent. of the number of all vessels navigating the Mississippi system during the fiscal year ending June 30, 1888. It includes all of the powerful towboats of the Pittsburgh coal companies, of the iron transportation companies, and of the Mississippi Valley Transportation Company, as well as the lumber rafting-boats of the Upper Mississippi River. Ninety-five per cent. or more of the commerce in tonnage of the western rivers is carried on by the boats of this class or in barges propelled by them. Some of the paddle-wheel boats of this class like the St. Paul Packet *War Eagle* are over 75 feet in width across their paddle-boxes and can not reach the terminus of the channels ordered estimated for at La Salle through the existing locks on the Illinois River. These locks must be regarded with other existing conditions governing the question of the dimensions of the proposed channel and its locks.

"The largest Mississippi River steam-boat" that now reaches the mouth of the Illinois River in length and draught is the St. Paul Packet *St. Paul*, which is 300 feet long and 6 feet 2 inches depth of hold. This boat is 70 feet across her paddle-boxes and is a fair type of the "largest Mississippi steam-boats" that will seek this route at extreme low water in the Upper Illinois and Desplaines Rivers. Its net tonnage exceeds 800 tons, but larger boats exist that can use the route at extreme low water.

A lockage at La Grange Lock is made once in eleven minutes. At this rate four lockages may possibly be made, passing as many boats

each way per hour. The extreme capacity of one of these locks, which governs the capacity of the entire route as a means of transportation, is then, on the basis of boats like the *St. Paul*, 6,000 tons in round numbers per hour, or 29,000,000 tons, in round numbers, in two hundred days, the shortest probable period of navigation, or one-half that amount if boats be moving in one direction only.

The possible capacity at extreme low water of the channel 8 feet deep is thus more than sufficient for all probable demands upon it for many years to come. At higher stages boats of twice the tonnage of the *St. Paul* could use the route.

THE 14-FOOT CHANNEL.

The act of Congress in question requiring plans and estimates for a channel at least 14 feet deep and at least 160 feet in width, has been complied with, and estimates on this basis are also submitted. This channel will accommodate, of course, with greater facility, all large vessels that can reach its terminus at La Salle through the channel of the Mississippi River, at present about 4½ feet in depth at low water, to be increased if practicable to 8 feet at low water below St. Louis, and to 6 feet on the Upper Mississippi and through the Lower Illinois River, at present from 16 to 18 inches in depth on the unimproved section, to be ultimately 7 feet deep at extreme low water, with locks 350 feet in length and 75 feet in width of lock chamber. No vessels now existing on the Mississippi River that can not be accommodated by the 8 feet deep channel at extreme low water will be accommodated by the 14-foot channel 160 feet wide, but every increase in depth up to a certain limit of a navigable water-way increases the facility with which it can be navigated by large vessels; a channel from 14 feet in depth at extreme low water in Lake Michigan to 18 feet at high water across the Chicago Divide, can be navigated by similar large boats if still water, or with a very moderate current, with greater facility and ease than a still-water channel from 8 to 12 feet in depth. This is the best argument for such a channel, based upon the present or probable future navigation of the Mississippi River and tributaries; it is not a public necessity.

As for the practicability of such a channel under the condition imposed by the act that it shall occupy the bed of the Illinois and Des Plaines Rivers, more will be said hereafter in this report.

Artificial water-ways connecting superior navigations even, are generally restricted and obstructive, and limited by motives of economy to the least dimensions that will accommodate the vessels that will probably seek their use. For this reason, probably, no channel has been recommended, by any engineer under Governmental or State authority, exceeding 8 feet in depth across the Chicago Divide.

The strongest presentation of the necessity for a minimum channel 14 feet in depth from Lake Michigan to the Mississippi River, at the mouth of the Illinois River, is given by the chief engineer of the Chicago sanitary district, lately organized under the act of the Illinois legislature, approved May 29, 1889, entitled "An act to create sanitary districts and to remove obstructions in the Des Plaines and Illinois Rivers," in an article published in the *Chicago Tribune* dated January 29, 1890. It is given here because the author represents the only interest demanding a large channel, and presumably offers the most cogent arguments available for governmental action.

Criticising the statements contained in the Annual Report of the Chief of Engineers for 1889, p. 2130, *et seq.*, he says:

[The italics are mine, not appearing in the article in question.]

* * * * * * *

The Government is now engaged upon an improvement which will *secure* 10 feet at all stages below Cairo and 8 feet from St. Louis to Cairo. Certainly *if* it secures 10 feet to Cairo this will be extended to St. Louis, as suggested by the Mississippi River Commission. We may be sure that this minimum depth will *sometime* be obtained to St. Louis, and that *when it is*, the ordinary boating stage will be as much in excess as now, or not less than 14 feet to St. Louis.

* * * * * * *

If these depths were maintained, no one questions that the utility of greater depths would be apparent and would be undertaken. * * *

If, however, a minimum depth of 10 feet *is to be secured* to St. Louis, it is *certainly practicable* to carry it over the same river, precisely to the mouth of the Missouri, 16 miles above, and then *only* 24 *miles intervenes to the mouth of the Illinois.*

No one will contend that this depth can not be had over this 24 miles, *if* there is any wise purpose to be subserved, as there would be.

And here the gentleman leaps to Lake Michigan, seeking the mother of invention to help him over that 24 miles, and begs the entire question before he can get further with his 10-foot improvement.

If we can carry 14 feet from Lake Michigan to the Mississippi.

If the Government can improve 1,000 miles of river below St. Louis we need not be balked by 40 miles above to the mouth of the Illinois.

If the improvement below St. Louis is made on the basis of 10 feet,

It is progressing slowly and laboriously on the basis of 8 feet,

then we need 14 feet from the Illinois to Lake Michigan to meet that work, because the low-water stage on the Illinois is long continued,

He does not say how it is with the low-water stage on the Upper Mississippi, subject to nearly the same climatic conditions,

and we would only have a canal and slackwater navigation

subject to an oscillation of from 4 to 20 or more feet,

from Chicago to LaSalle, with little variation in depth.

The significance of the "*ifs*" and "*whens*" may be made apparent in part by stating that the first "if" presupposes the expenditure as originally estimated by the Mississippi River Commission of not less than $33,000,000 to secure 10 feet minimum depth below Cairo, which estimate has not been repeated in later reports, and might probably be modified by their experience. Whether the Government will "*secure*" 10 feet below Cairo is yet problematical. The Mississippi River Commission have satisfactory reasons for reporting that they have solved the question of the possibility of obtaining that depth, but its realization is distant. The possibility of *securing* that depth is not so clear. No one knows how many years or centuries of time, or dollars it will require, under appropriations irregularly made, to obtain the depth of 10 feet, or to maintain or secure the depth after obtaining it.

No estimate has yet been made of the cost of fulfilling the requirements of the second, "if," *i. e.*, to "*secure*" 10 feet minimum depth to St. Louis; $17,000,000, approximately total expenditure, is estimated to get 8 feet from St. Louis to Cairo. The consummation of this 8-foot project is not yet in sight, though favorably progressing. What it will cost to get and "*secure*" or even maintain by continued labor the additional 2 feet in that region of moving sands no one knows.

The same remarks apply to the third "if" in the progress towards the mouth of the Illinois. No estimates have been made to carry 10 feet to the mouth of the Missouri, nor to the mouth of the Illinois, nor 14 feet up the Illinois to La Salle, but for 14 feet from La Salle to Lake Michigan an estimate is herewith of more than $48,000,000.

The definite estimates then, so far submitted foot up nearly $100,000,000 and leave us, granting estimates correct and the work done and "secured," at St. Louis with 8 feet minimum draught below that city, and not exceeding 5 feet minimum depth above to La Salle.

It is evident, therefore, accepting the gentleman's conclusions, which do not necessarily follow, even from his hypotheses, that the necessity for the 14-foot channel is not urgent, and as far as navigation is concerned can wait, pending further consideration, without injury to public interests. All mechanical constructions would decay, if built now, before their full use would be available, awaiting the realization of the conditions expressed by the "ifs" and "whens," if built of the stone accessible to this line.

He concludes his argument—

* * * * * * *

No one in Chicago or in the Illinois Valley is interested in a 7-foot navigation. That is passing away after the stage-coach and plank-road.

Eight feet minimum is proposed across Chicago Divide, rising to from 10 to 12 feet across the divide, and to 20 feet in the rivers, with the oscillation of lakes and rivers. Less than 7-feet navigation exists on the Mississippi River to day, and upon all its branches and navigable tributaries, and upon every non-tidal river, probably, on the globe, not slack-watered or canalized around obstructions, and on nearly every canal on the globe not connecting tidal or deep waters.

All commerce by means of non-tidal waters (excluding inland lakes and seas) of the world, except an insignificant percentage, is effected on boats and barges of 7 feet or less draught of water, and interest in a 7-foot navigation will cease in Chicago when the Erie Canal no longer exists, and generally when all rivers and canals, as well as men, are thoroughly regenerated.

SUMMARY AND CONCLUSIONS.

From the lists herewith, the following tabulated statement has been prepared:

Steam-boats navigating Mississippi River and tributaries.

Depth of hold.	Vessels.	Tonnage.	Number.	Tonnage.
			Per cent.	*Per cent.*
Over 9 feet	*3	4 961.78	0.4	2.7
8 feet to 9 feet inclusive	14	16 674.91	1 9	9.2
Less than 8 feet	712	159, 666.92	97.7	88.1
Total	729	181, 303.61	100	100

* No longer exist.

NOTE.—If the number and tonnage of barges of 8 feet draught and less, which carry the heavy freights of the Mississippi River and tributaries were added, the percentages of tonnage on the Western rivers in hulls exceeding 8 feet depth would appear insignificant.

As a class the "largest Mississippi River steam-boats" are 9 feet or less depth of hold; 9 to 10 feet extreme draught; 70 to 78 feet width over paddle-boxes.

At least one of the class has an extreme load draught of 10½ feet and an extreme width of 85 feet.

None of this class as wide as 75 feet can pass the locks on the Illinois River below La Salle, and, consequently, need not be considered in planning works between La Salle and Lake Michigan as long as these locks exist. Nor can boats 75 and more feet wide safely pass each other in a rough rock-bound channel 160 feet wide, especially if there be a current therein.

The "largest Mississippi River steam-boat" that reaches the mouth of the Illinois is 300 feet long, 70 feet wide, 6 feet 2 inches depth of hold, and about 7 feet, more or less, extreme load draught, not habitually carried even at high stages of water.

The least channel proposed will accommodate such boats and 97 per cent. of all steam-boats navigating the Mississippi River and tributaries in number and 88 per cent. in tonnage.

Facilities adequate for boats similar to the "largest Mississippi River steamboats," that *do not* reach the mouth of the Illinois River and *can not* reach the terminus of the proposed channel at La Salle, would require a depth of cut at extreme low water in Lake Michigan across the Chicago divide of 9 feet, a width of 200 feet in artificial channels and canals, a depth in canals of 10.80 feet, and locks 350 feet in length and 87 to 90 feet in width of lock chamber.

No increased depth in river channels over bars and on miter-sills than will be obtained by the execution of the 8-foot project is required for even these boats, the natural oscillation of the Upper Mississippi and Illinois Rivers being governed by similar conditions, and these exceptionally large boats not being able to reach the mouth of the Illinois River except at good navigable stages.

No greater depth of channel than 9 feet at extreme low water in Lake Michigan across the Chicago Divide seems *necessary* for navigation by vessels similar to the largest Mississippi River craft that can not use it nor reach it; but a channel of much greater capacity, discharging a large volume of water into the Illinois and Des Plaines rivers not necessary for navigation in a canalized river, as this must necessarily be, is made locally urgent by the sanitary necessities of the city of Chicago for drainage and an uncontaminated water supply, as shown in the appendix to this report. These necessities end when the Chicago Divide is passed and the discharge turned into the channels of the rivers. Beyond the Chicago Divide, then, there is no apparent necessity at present, nor likely to exist in the near future, either national or local, for any channel of materially greater capacity than the minimum herein estimated for between the Mississippi River and the Great Lakes, but every increase in depth and width of channel up to a certain limit throughout the artificial channels will increase the facilities for navigation without probably affecting the character, size, or draft of the boats that will use it as a through route of transportation, *i. e.*, Western river steam-boats, barges, and tow-boats.

LOCATION AND ESTIMATES.

The accompanying report of Assistant L. L. Wheeler gives such a full description of the various routes surveyed that it is unnecessary to again repeat it herein, and reference is made to his report and the maps and profiles herewith submitted for such details. In locating the proposed routes and structures required, and in determining the bases of the estimates, much study was devoted by Mr. Wheeler and myself

in this office, and his reported locations and estimates have been made after the various points involved were thus determined, and under the instructions of the Department.

The two routes estimated for, *i. e.*, via Chicago River and via the Calumet River and the "Sag," unite at the Sag Bridge, about 17 miles from Blue Island and Bridgeport, and thence to La Salle coincide.

CHICAGO RIVER ROUTE.

The route proposed follows the Chicago River from its mouth, via its south branch to near Bridgeport, thence via the West Fork of the south branch and the Ogden Ditch to Summit, thence parallel to the present location of the Illinois and Michigan Canal, on lower ground, 3 miles, more or less, where it enters the bed of the Des Plaines River, which it practically follows, cutting off bends to Sag Bridge, where it unites with the second or Sag route.

The route is preferred to the present location of the Illinois and Michigan Canal, or one adjacent to it.

(1) Because it occupies lower ground, and the probable amount of excavation required is less, since the earth excavated from the old canal still remains as spoil banks to be removed.

(2) Because the old canal is paralleled by a railroad on each side, and there is not sufficient room for the enlargement of the canal without condemning the railroad right of way and removing one or both of the tracks.

(3) Because the present canal is the property of the State of Illinois and the conditions of transfer have not been accepted by the United States. These conditions are such that their acceptance would involve greater cost than a new right of way.

(4) The Illinois and Michigan Canal is the main sewer of the city of Chicago, as well as a commercial highway, and can not well be enlarged without either interfering seriously with its uses or at increased cost of work from delays due traffic upon the canal.

(5) As a means of transportation and drainage it is of advantage in the prosecution of the work parallel to it to maintain it in a serviceable condition during the construction of the larger canal.

(6) For several miles of its course between Willow Springs and Lemont it is excavated in solid rock that the new route avoids, so that the old canal location could not be followed in any event with advantage further than throughout the earth section.

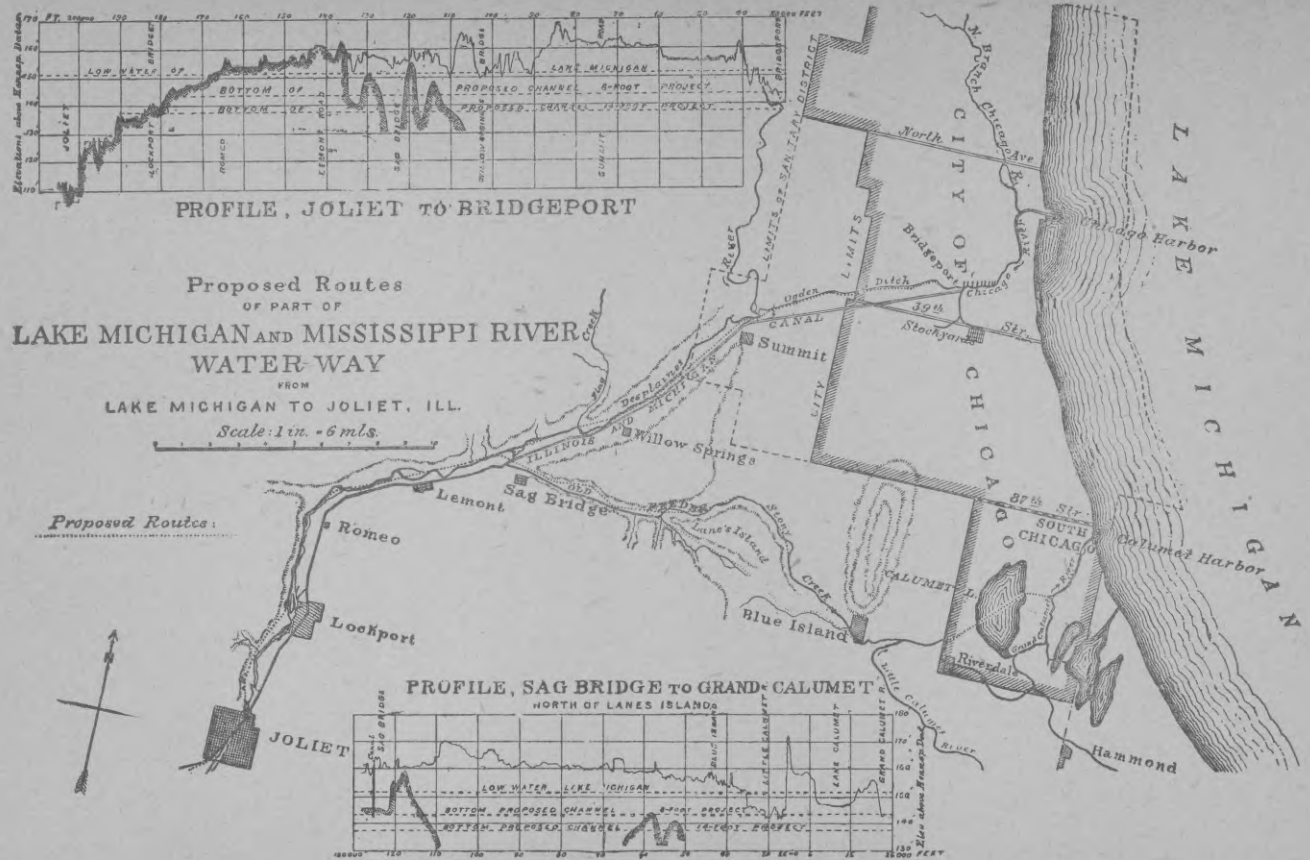
SAG OR CALUMET ROUTE.

The proposed route is via Grand Calumet River to 108th street; thence via a cut-off through Lake Calumet, to its south-western shore; thence by another cut-off, to the Little Calumet River; thence to Blue Island; thence nearly due west via, practically, the line of the old Calumet Feeder, north of Lane's Island, to the junction of the two routes at Sag Bridge.

The line through Calumet Lake is more expensive than by way of the rivers to Blue Island, but is preferred:

(1) Because it is 5 miles shorter.

(2) Because Lake Calumet offers great facilities for the construction, at small expense, of an unobstructed land-locked harbor of great proportions, affording ample room for a turning basin, and a great development of docks and wharves suitable for an extensive commerce, and easy transfer between lake and river steamers.


PROFILE, JOLIET TO BRIDGEPORT
Proposed Routes
OF PART OF
LAKE MICHIGAN AND MISSISSIPPI RIVER
WATER WAY
FROM
LAKE MICHIGAN TO JOLIET, ILL.
Scale: 1 in. = 6 mls.
Proposed Routes
Romeo
Lockport
JOLIET
Lemont
Sag Bridge
Willow Springs
Summit
CITY OF CHICAGO
LAKE MICHIGAN
North Chicago Ave
Bridgeport
39th Str.
87th Str.
SOUTH CHICAGO
Calumet Harbor
CALUMET R.
Blue Island
Riverdale
Hammond
Chicago Harbor
PROFILE, SAG BRIDGE TO GRAND CALUMET
NORTH OF LANES ISLANDS

H. Ex. 264 51 1

The route north of Lane's Island, though about 2 miles longer than the direct line south of the island, is preferred on account of the nature of the material south of Lane's Island, which, for several miles, is a soft muck, peat, and vegetable matter, that will make the maintenance of of a definite channel extremely difficult and expensive.

The material encountered throughout the two routes is of the same character, differing in proportions. Clay, common earth, sand, glacial drift, such as gravel and bowlders, some quicksand, and solid limestone rock.

It is believed that the most advantageous, but not the least expensive, route is estimated for via the Sag, and the least expensive and most available route is selected via the Chicago River, for the estimates submitted. Over each route one guard-lock to prevent Des Plaines flood water passing into Lake Michigan, carrying Chicago sewage, is estimated for.

The estimates are given in detail in the report of Assistant Engineer Wheeler, hereto appended.

The following table gives consolidated comparisons of the cost of the preferred locations along the two routes as far as Sag Bridge. The quantities, etc., via the alternative locations over each route, are given by Mr. Wheeler. No estimate is made for damages to adjacent property due to the reconstruction of bridges in Chicago, which would be a large item of cost, nor for the increased cost of the work via the Chicago route over that via the Sag, due to the interruptions by Des Plaines River floods.

The Chicago route is more difficult than the Sag route on this account.

The prices stated in the estimates were adopted after consultation with experienced quarrymen and contractors, and are believed to be reasonable. The estimate for right of way in Cook County was made by an experienced real-estate firm in Chicago.

Comparative cost from Lake Michigan to Sag Harbor.

Item of cost.	Chicago route.				Sag route.			
	14-foot project.		8-foot project.		14-foot project.		8-foot project.	
	Units.	Cost.	Units.	Cost.	Units.	Cost.	Units.	Cost.
Right of way	.....	$1,197,250	.....	$1,197,250	.....	$272,150	.....	$272,150
Bridges	34	2,865,000	34	2,865,000	27	1,055,000	27	1,055,000
Rock	497,800	796,480	251,000	401,600	1,264,700	2,023,520	536,800	858,880
Earth	413,000	165,200	413,000	165,200	13,814,000	3,453,500	9,562,000	2,390,500
	9,989,000	2,497,250	6,730,000	1,682,500				
Hard pan	1,360,000	816,000	920,000	552,000	944,000	566,400	703,000	421,800
Guard-lock	1	368,130	1	283,819	1	357,649	1	268,309
Docks	*11,500	172,500	*11,500	172,500	.....	.....	.....	.....
Revetment	*84,000	840,000	*84,000	672,000	.....	.....	.....	.....
Contingencies, 10 per cent	.....	971,781	.....	799,187	.....	772,822	.....	526,664
Total cost	.....	10,689,591	.....	8,791,056	.....	8,501,041	.....	5,793,303

* Feet.

At Sag Bridge the various routes from Lake Michigan unite, and thence the proposed canal follows practically the present bed of the Des Plaines River to below Lockport, the 14-foot channel being cut through solid limestone rock its full depth, from a point 134,000 to a point 168,000 feet distant from Lake Michigan, and partly in rock from

126,000 to 134,000, and from 168,000 to 184,000 where the bottom of the 14-foot channel reaches the surface below Lockport. The line from Lockport to Joliet follows the west side of the Des Plaines Valley.

Descending by four locks in the 14-foot project, and five locks in the 8-foot project, the canal enters the second basin at Joliet. Waste-gates are provided for below Lockport to vent the waters of the Des Plaines at such times as they may exceed the necessities of the canal and overtop the guard-lock gates, and are of sufficient capacity to vent the natural high-water discharge of the Des Plaines. These gates will but seldom, and for short times, be used to their full capacity. A constant flow will not be maintained through them. They will only be opened when there is an apparent necessity for venting flood waters.

The canal below Lockport, in both projects, is nearly entirely in embankment, or above the natural surface, the side-hills to the west forming one limit to the canal, and substantial masonry retaining walls laid in cement mortar and backed with the stone from the excavated parts of the canal forming the other side of it, as well as the dams between levels, which extend from the locks to the bluffs.

This substantial construction is recommended for the security of the city of Joliet, which lies below the levels of the canal. It is not the cheapest construction.

From the first lock at Lockport to below Joliet the bottom of the two proposed channels are made to coincide, the difference of cost in the two projects being due to the different heights of lock walls and retaining walls and dams, and not to difference in excavation, which is the same throughout this section for the two projects.

From Lake Michigan to Lock No. 1, near Lockport, the rock excavation for the 14-foot project is:

	Cubic yards.
Via Chicago route	5,222,700
Via Sag route	5,989,600
And for the 8-foot project:	
Via Chicago route	3,173,000
Via Sag route	3,458,800
The earth, including hardpan, gravel, and bowlders, and generally everything that can be removed by dredging or without blasting, for the 14-foot project:	
Via Chicago route	12,434,000
Via Sag route	15,430,000
And for the 8-foot project:	
Via Chicago route	8,624,000
Via Sag route	10,826,000

The increased cost of the Chicago route, which involves the less cubic volume to be removed, is due to the greater value of right of way, the cost of widening and docking Chicago River and parts of the canal, and the cost of reconstructing bridges and approaches, no consequential damages being estimated.

These items are given separately, to show the amount of material in level cuts 160 feet wide across the Chicago Divide, 14 and 8 feet deep, respectively, below Chicago city datum.

At Joliet it is proposed to remove both State dams; to lower the water-surface of the first pool 2 feet for the 14-foot project, and to raise the surface of the second pool 8 feet, building substantial masonry laid in cement retaining-walls 5 feet above the constant water-level; to build a new dam at the foot of this pool and place in it a movable section or sluice-way, closed by a controllable gate, probably a modified "bear trap" of the "Parker" pattern, to vent floods; to construct along the

retaining-wall on the east side a culvert or drain to carry off sipe water; to widen the Illinois and Michigan Canal by rock excavation to 160 feet; to deepen it 8 feet by raising the canal embankment by constructing masonary retaining-walls; to insert in this wall, if necessary, additional sluice-ways closed by cylindrical gates of the "Taintor" type, to supplement the discharge through the sluice-way of the dam at floods; to build below these sluices a guard-lock, and to continue the level to a point 1½ miles below Joliet, where a lock is placed of 8 feet lift to again return to present levels in the Illinois and Michigan Canal. The line then leaves the present canal in a direct line to Lake Joliet, and thence to La Salle occupies the beds of the Des Plaines and Illinois Rivers, except at Marseilles, where a short canal is constructed around the rapids at that point.

For the 8-foot project at Joliet the upper basin is lowered 8 feet, the dam at the end of the second basin is to be raised 2 feet, and the canal banks raised 2 feet and the canal widened as before. To vent flood waters, similar constructions are proposed to those enumerated above for the 14-foot project. This level of the Illinois and Michigan Canal, if its use be continued after the construction of the larger work, must be raised throughout, 2 feet.

In the river portion of the route the required depths are obtained by the aid of dams, as far as practicable. The dams are proposed to be as high as admissible, without too great damage by flowage, and the additional depths required are obtained by excavation in the beds of the river. The water-surfaces are, therefore, common to the two projects. The excavation required over the river section for the 14-foot project is very great and expensive, and the material if not entirely removed from the high-water channel will diminish its capacity. The estimates are not based upon the removal of this material and placing it upon the top of the banks, but simply for removing it from the navigable channel and its deposit within the banks where it will not probably re-enter the excavated channels. If it be desired to enlarge the capacity of the natural channel of the Upper Illinois this excavated material must be removed beyond the high water-limits at increased cost.

The mechanical constructions proposed are: For the 14-foot project, three guard-locks; one combined lock of two lifts, and fifteen lift-locks from Lake Michigan to La Salle, the total lockage being 141 feet, and for the 8-foot project, three guard-locks and sixteen lift-locks, with one set of waste-gates for each project at Lockport. Nine dams, one of which, viz., at Joliet, is provided with a controllable sluice-way, and two others, viz., one at Sugar Island near Morris, and one at the foot of the slope at Utica, are provided with navigable passses closed by Chanoine wickets. These are the only two locations where it will be practicable to employ movable dams, the slope of the rivers making permanent dams necessary.

The locks at all fixed dams are carried above the high-water mark, and the discharge of the river forced by levees or embankments over the crests of the dams.

The total estimates for the two projects from Lake Michigan to La Salle, are as follows:

For the 14-foot project:	
Via Chicago Route	$48,282,763
Via Sag Route	46,094,213
For the 8-foot project:	
Via Chicago Route	26,883,153
Via Sag Route	23,885,400

The various items of cost are given in detail in Mr. Wheeler's report, and in the detailed estimates of cost of locks and dams hereto attached.

Condensed tables are given below, showing the cost of the different sections of the proposed route, from which may be seen that the part of the route from the mouth of the Kankakee to Utica is the most expensive section, aggregating for the 14-foot channel 66 per cent. *more than the cost of the expensive section from Sag Bridge to Joliet*, which includes the rock cut across Chicago Divide.

Estimates of cost.

Item.	Material.	14-foot project.	8-foot project.
Chicago Route (Lake Michigan to Sag Bridge):			
Dredging Chicago River		$69,200	$69,200
Widening Chicago River		96,000	96,000
Docking Chicago River		172,500	172,500
Excavation, Bridgeport to Sag Bridge	Earth	2,497,250	1,682,500
	Hardpan	816,000	552,000
	Rock	796,480	401,600
Docking, Bridgeport to Sag Bridge		840,000	672,000
Bridges		2,865,000	2,865,000
Right of way		1,197,250	1,197,250
Guard-lock at Summit		368,130	283,819
Contingencies, 10 per cent		971,781	799,187
Totals		10,689,591	8,791,056
Sag Route (Lake Michigan to Sag Bridge):			
Excavation—Grand Calumet River to Blue Island, Ill.	Earth	773,750	406,500
Excavation—Blue Island to Sag Bridge	Earth	2,679,750	1,984,000
	Hardpan	566,400	421,800
	Rock	2,023,520	858,880
Bridges		1,055,000	1,055,000
Right of way		272,150	272,150
Guard-lock at Sag Bridge		357,649	268,309
Contingencies, 10 per cent		772,822	526,664
Totals		8,501,041	5,793,303
Sag Bridge to Joliet, Ill.:			
Excavation	Earth	168,000	140,250
	Rock	7,585,120	4,713,920
Waste-gates at Lockport		72,955	61,653
Lock No. 1		444,372	323,249
Lock No. 2		368,199	303,861
Lock No. 3		389,526	299,001
Lock No. 4		465,450	315,894
Lock No. 5			391,308
Excavation in basin at Joliet	Earth	6,000	6,000
Retaining-walls above Joliet		717,700	382,800
Retaining-walls at Joliet		140,550	56,300
Bridges		410,000	410,000
Right of way		142,440	142,440
Movable dam		52,908	30,114
Contingencies, etc., 10 per cent		1,096,322	757,679
Totals		12,059,542	8,334,469
Joliet to Kankakee River:			
Guard-lock at Joliet		316,788	249,979
Lock No. 5		363,970	
Lock No. 6		*613,922	333,740
Lock No. 7			307,640
Lock No. 8, Treat's Island		449,759	341,400
Lock No. 9		562,921	450,879
Excavation	Earth	36,250	
Excavation	Hardpan	249,400	106,600
Excavation	Rock	1,354,400	272,000
Bridges		45,000	45,000
Right of way		208,330	208,330
Retaining-walls		170,940	32,260
Dams, Treat's Island		139,583	139,583
Dams, Lock No. 9		75,398	75,398
Contingencies, 10 per cent		458,666	256,281
Totals		5,045,327	2,819,090

* Combined in 14-foot project.

Estimates of cost—Continued.

Item.	Material.	14-foot project.	8-foot project.
Kankakee River to La Salle:			
Lock No. 10		$569,592	$459,654
Lock No. 11, Sugar Island		423,989	335,610
Guard-lock, Marseilles		336,432	246,159
Lock No. 12		360,640	268,351
Lock No. 13		376,484	282,778
Lock No. 14		595,847	483,533
Lock No. 15		571,893	454,013
Lock No. 16		502,736	399,547
Excavation	Earth	1,784,500	381,500
	Rock	11,680,800	1,573,800
Retaining-wall at Marseilles		95,040	95,040
Bridges		340,000	340,000
Right of way		89,600	89,600
Dam at Lock No. 10		120,486	120,486
Dam at Lock No. 11, Sugar Island		119 273	119,273
Dam at Marseilles		102,851	102,851
Dam at Ottawa		189,872	189,872
Dam at Lover's Leap		191,371	191,371
Dam at Utica		174,324	174,324
Contingencies, 10 per cent		1,862,573	630,776
Total		20,488,303	6,938,538

Table of elevations from Lake Michigan to last proposed lock at Utica, Ill.

Location.	Distance.	Low water.		High water.	
		Elevation.	Fall.	Elevation.	Fall.
	Miles.				
Lake Michigan		151.5			
Lockport	33.5	144.0	7.5		
Dam No. 1, Joliet	38.8	110.0	34.0	113.4	53.4
Dam No. 2, Joliet	39.4	100.0	10.0	104.4	9.0
Lake Joliet	41.9	75.0	25.0	82.3	22.1
Kankakee River	54.2	58.5	16.5	82.3	
Marseilles Dam	79.7	50.0	8.5	58.3	24.0
Lock No. 13, foot of Marseilles Rapids	81.1	32.8	17.2	49.8	8.5
Utica	97.0	10.5	22.3	36.1	13.7

COMPARATIVE ADVANTAGES OF THE TWO ROUTES FROM SAG BRIDGE TO LAKE MICHIGAN.

The Chicago River and its branches, with its docks and slips, constitute the harbor of Chicago, where all business of the port by lake craft except a comparatively insignificant amount at the Illinois Central Docks and Ogden Slip, is transacted.

The arrivals and departures of vessels have reached the enormous aggregate of over 22,000 annually, in a season of navigation of about seven months, making Chicago the first port in the United States, as far as the number of arrivals and departures is concerned.

Along this river are great lumber and coal yards, grain elevators, meat-packing establishments, and, generally, all the means and appliances, and paraphernalia of the great commerce by lakes centering at Chicago, as well as the facilities for transfer from rail to water transportation.

If the Chicago River could be made, at reasonable expense, capable of permanently accommodating the increased commerce that the opening of a through route of transportation of great capacity between the lakes and the Mississippi River will probably bring about, there could be no question of the proper terminus of the line, as far as the interests

of commerce are concerned. But, on the other hand, the river is very crooked, and obstructed by numerous swing bridges, nearly all of them of less than 80 feet clear span, and in any movement loaded vessels require the assistance of tugs.

The main river and its South Branch cut off the business center of the city from the populous north and west sides, and it requires the most careful management by city officials to accommodate the streams of pedestrians and vehicles, and the passing vessels. The opening of a bridge at times blocks up the streets for long distances, and at certain hours of the day vessels are detained by closed bridges.

This great inconvenience, in spite of quick-turning bridges, is daily becoming more burdensome and annoying to both land and marine interests, and the river can not accommodate any material increase in the number of vessels using it.

No betterment of the present state of affairs with reference to the bridge nuisance can be expected, for no other navigable approach can be had to the lake within the old city limits, save at an expense greater than the entire cost of the Southern or Sag route.

The business of the city still continues to concentrate more and more within the narrow space south of the main branch of Chicago River, north of Twelfth street and east of the South Branch. The construction of enormous buildings, fourteen stories or more in height by increasing the capacity of the limited area and the density of the business population, is constantly increasing the traffic and crowds seeking the bridges.

Doubtless it is only a question of time when the space now occupied by elevators, lumber and coal yards, docks and wharves, will to a great extent become too valuable for such uses, under increasing annoyance and delays, and the purposes of navigation be subserved otherwise—by barges and tugs; by the construction of an extensive outer harbor for lake vessels, with wharves and docks along the lake front of the city, or by the utilization of the great facilities of the Calumet system of lakes and rivers, making fixed bridges across Chicago River a possibility.

But of all influences that will diminish the number of lake vessels resorting to the Chicago River, and increase its use by tugs and barges, finally resulting in fixed bridges, the necessities of the city for better sanitary arrangements and for a satisfactory disposition of its sewage will be, in my opinion, the most absolute and conclusive. Attached to this report will be found the full preliminary report of the special commission, or board of experts, employed by the city of Chicago to examine into the question of drainage and water supply, made in 1887; also the laws and joint resolutions of the legislature of the State of Illinois relating to the same matter, and authorizing the establishment of "sanitary districts, etc.," which will give a clear explanation of the requirements of the case and the proposed remedies.

Without going into the subject in detail, which is better treated in the report mentioned than it could be by me, it is sufficient to state that after examination by capable experts, the conclusion has been arrived at that it is necessary, for sanitary reasons, to construct a channel or channels from the lake to the Des Plaines Valley, beyond the Chicago Divide, capable of carrying to the Illinois River from 300,000 to 600,000 cubic feet of water per minute, to carry off and dilute to inoffensiveness the sewage of this great city, to prevent contamination of its water-supply, necessarily taken from Lake Michigan; and that the necessary legislation to enable the city to undertake the work has been obtained from the State legislature.

Many propositions have been bruited, involving various schemes for the diversion of the flood waters of the Des Plaines; channels of large

capacity in addition to, and to supplement, the natural drainage lines of the Chicago River and the main drainage canal, etc., but up to this date no perfected plan has been formulated or adopted.

Whatever may be the ultimate fate of the various proposed cut-offs and diversions and auxiliary channels, it may safely be reasoned that economy will govern, and that the essential objects of the city of Chicago will be first obtained by the most direct and inexpensive use, to their full capacity, of the natural drains, with such sewers, conduits, and pumping works as will secure proper outfalls into these drains, and satisfactory transfers of the contents of otherwise dead branches to the main drainage channel, *i. e.*, by the utilization to the full extent allowed by the law of the Chicago River and its branches.

From this may be inferred a current of not exceeding 3 miles an hour in the Chicago River and its South Branch.

Any marked current in such an obstructed stream means danger to the heavy and unwieldy vessels that frequent it, especially if built of metal; and doubtless a current of even less than 3 miles an hour obstructed by numerous stone piers, a multitude of vessels, and many sharp bends will have its effect upon rates of insurance and upon the minds of vessel-owners and owners of dock property.

In its present condition Chicago River can not be navigated at all by large Mississippi River steam-boats. Nearly all the bridges, which are the property of the city of Chicago, must be reconstructed if this route be adopted and a material increase in the already too great number of vessels using the river result. No large Mississippi River steam-boat can turn in the river, but must run the gauntlet of all its bridges and piers, after reconstruction, to Lake Michigan for that purpose, or else a commodious turning-basin be constructed for such purposes.

In the practical execution of a channel via this route the Des Plaines waters must be contended with and may materially increase the cost of the route, but as there has been expressed by contractors of experience a doubt upon this point, based upon the ground that the facilities for dredging from Bridgeport to Summit are better and that the material can be sold to brick-makers and for filling to reduce the ultimate cost, the estimates over the two routes are made on the same basis of cost per unit.

Generally speaking, then, it may be stated that the Chicago River is a very unfavorable terminus for this highway as far as the interests of navigation are concerned, also as far as future demands and facilities for increased commerce by water are concerned, but that for sanitary purposes a channel along substantially this line has been decided to be a vital necessity for the city of Chicago.

SAG OR CALUMET RIVER ROUTE.

The terminal facilities as far as possible access to Lake Michigan at numerous points along the Calumet River and system of lakes connected therewith are concerned, the ample land-locked natural basins (needing only deepening by dredging) for the construction of a great development of wharves and docks and commodious harbors in public waters of the United States scarcely excelled anywhere on the great lakes, point irresistibly to the Calumet region as the proper terminus of a great water-way between the Great Lakes and the Mississippi River.

The Calumet Harbor is about completed, and the United States have secured the riparian rights to the river front from the mouth of the river at the harbor as far as to the forks of the Calumet, or the present outlet to Lake Calumet, which section of the river the Government is now engaged in dredging to a depth of 16 feet and a width of 200 feet.

The Grand Calumet River extends for miles nearly parallel to, and a short distance from, Lake Michigan from "The Forks" in the State of Illinois, to its old mouth in the State of Indiana, and with its lakes offers commodious basins, and easy and comparatively inexpensive connections, at many points between the proposed channel and Lake Michigan.

The Calumet River has been recognized by appropriations made by Congress as one of the navigable rivers of the United States. The United States is the riparian owner over a considerable stretch of the river, and can control the matter of bridging the stream absolutely.

The development of the region so far is such that without great expense the terminal facilities may be made in every way adequate for the heaviest commerce, and the logic of necessity and the tendency of events are towards the development of water traffic, and not towards its decadence, as is the case with reference to the Chicago River.

The estimated cost of the route is materially less than that via Chicago River; its execution is easier, even if not less expensive per unit of work, as there are no rivers whose floods may delay or stop work over this section from Lake Michigan to Sag Bridge, and, finally, there is no strong local necessity disconnected from the interests of navigation to control or interfere with the execution of the work on a strict national basis.

With reference to this last remark it may be said, on the other hand, that it will not have the strong local support of Chicago to secure appropriations and expedite the project as would the Chicago route.

But should Congress authorize the enlargement and use by the city of Chicago, for drainage purposes, of any channel that may be constructed by the United States across the rock barrier at Lemont, which must be cut for any channel across the Chicago Divide, under proper restrictions as to dimensions of the enlarged channel, velocity of current, and Governmental control of the discharge through it, to limit the liability of the United States for flowage of lands along the Illinois River due to water not necessary or advantageous for navigation, but passed through United States channels, doubtless much of the opposition to the Sag route would disappear.

PRACTICABILITY OF THE PROPOSED CHANNEL, DISCHARGE OF THE ILLINOIS RIVER, AND EFFECT OF DAMS IN THE BED OF THE ILLINOIS.

The proposed channel from Lake Michigan to Lake Joliet is nearly entirely artificial; in other words, a canal. This canal, for short distances, enters the bed of the Des Plaines River, and is subject to its floods throughout these short stretches. The maximum amount of this flood water to be provided for at long intervals, will probably not exceed 10,000 cubic feet per second under present conditions. The average spring freshets do not probably exceed from 3,000 to 6,000 cubic feet per second. The canal with its waste gates and weir at Lockport; the controllable sluice-gate in the dam at Joliet; the additional sluice-gates in the canal revetment below the dam and above the guard-lock at Joliet (not estimated for), taken in connection with the high retaining-walls and the allowable depth of overflow over the crest of the Joliet Dam, will safely pass this water.

This part of the route, or the canal section, as designed, is, then, considered feasible and practicable, with the understanding that possibly a secure levee may be demanded from the dam at Joliet, along the left bank of the Des Plaines as far as to the flats below the Adams dam, to

prevent overflow when the sluices at Joliet are opened to their full extent.

The discharge over the dams above the mouth of the Kankakee is not, in any case, likely to exceed from 16,000 to 23,000 cubic feet per second. Such discharge is contemplated in the constructions, and may be passed over the dams.

There is, then, no engineering difficulty, or any apparent reason why the constructions proposed, with slight modifications that would not materially increase the estimates, will not satisfactorily subserve the purpose of a navigable channel as far as to the mouth of the Kankakee.

Here, however, the conditions radically change. The low-water discharge of the Illinois River, which below the mouth of the Kankakee and over the Marseilles dam does not exceed 1,000 cubic feet per second, including the supply by the Illinois and Michigan canal, increases, at extreme floods, until, as indicated by the high-water marks above the crest of the Marseilles dam, it reaches 63,000 cubic feet per second at Marseilles. This result is given by "Francis'" formula. If the velocity of approach due a slope of 2 feet to the mile, as shown by high-water marks for 5 miles above the Marseilles dam, be considered, the extreme flood discharge over the crest of the dam at Marseilles would probably be estimated at about 70,000 cubic feet per second.

The draining of the Kankakee marshes by a cut through the rock barrier at Momence, Ind., now contemplated, will certainly not lessen the ratio of 70 to 1 between flood and low-water stage, nor will the constant discharge into the Illinois River of from 300,000 to 600,000 cubic feet per minute, contemplated by the city of Chicago for drainage purposes, lessen the flood discharge, which determines the practicability of the route for all stages.

The dams on that portion of the route are proposed to be built as high as the topography of the valley will warrant, without extensive permanent overflow of lands or without materially increasing damage by floods, and the depths required, where not produced by these dams in the pools above them, secured by excavation.

These dams have their crests from 10 to 18 feet or more below the high-water plane, and at extreme flood stage will exercise no appreciable influence over the high-water levels, slopes, and velocities. If the river be not navigable now at flood stage over the reaches named below, it will not be navigable at flood stage after the construction of the proposed works, *i. e.*, from Lover's Leap to foot of Marseilles Canal, 14 miles, for 5 miles above Marseilles dam, and for 3 miles below the mouth of the Kankakee, where the high-water slopes are excessive; in all, 22 miles out of the 43 miles that intervene between the mouth of the Kankakee and the last dam at Utica.

The route will be navigable at all stages below a stage corresponding to a discharge of from about 30,000 to 35,000 cubic feet per second, or under all ordinary conditions of the river, the extreme floods occurring at rare intervals, and then being of short duration.

A route navigable at all times and in all conditions of the river can be obtained in four ways via the valley of the Illinois River:

(1) By canaling past the 22 miles indicated, practically in the bed of the river, with embankments above high-water mark.

(2) By raising the dams, or by shortening the lengths of spillways, until the sectional area of discharge throughout the pools is much greater than the area of discharge over the dams, converting the pools into reservoirs.

(3) By excavating and enlarging the cross-sections of the pools until the same result is attained.

(4) By constructing a lateral canal throughout the line.

Any of the first three methods will involve a greater expense than would the fourth, or continuous canal from Joliet to La Salle; the first method, because of the increased cost of the canal, with costly guard-locks in connection with costly river improvement over the sections where slack water is retained; the second method, by increasing the damages by flowage of valuable lands, and by increasing the height and cost of dams and lock-walls, and the difficulty of securing the abutments and connections with the banks; and the third, by enormously increasing the amount and cost of excavation.

It must be understood, therefore, that the constructions proposed herein are considered to be adequate to create a navigable water-way in the bed of the Illinois River, below the mouth of the Kankakee, at all ordinary stages of the Illinois River, but that during the short and widely separated floods the route may be found impracticable to use over the reaches named herein. Attention is invited in this connection to the report of Mr. L. L. Wheeler, which contains a short mathematical discussion of this subject.

The Kankakee River brings down large quantities of heavy sediment, which has been deposited in the deeply cut trough above the rock uplift at Marseilles, until that trough of unknown depth has been filled with gravel and sand nearly to the crest of the reef at Marseilles. Under the 14-foot project, and to a less extent the 8-foot project also, the material must be excavated to get the proper depth. The present condition of the bottom of the river exhibits, doubtless, the state of equilibrium that has been established between the scouring action of floods and the capacity of the heavy deposit to maintain its position. The more this condition is disturbed, or the deeper the material is excavated and the current of the river reduced, the greater will be the deposit of heavy sediment in the channel, gradually diminishing until this equilibrium is again restored.

The Marseilles dam will be, at high water, in practically the same condition as now, as it is proposed to get the two feet increased height of crest by a movable crest, which will be thrown down at floods. The dam below the mouth of the Kankakee and at Sugar Island will be drowned out, and practically the same condition will exist throughout the reach at high water as at present, except in so far as the velocity and slope may be disturbed, however slightly, by this channel excavation. We may expect, therefore, a constant effort of the river to restore, at least, its present condition by filling up the excavated channels.

In the 8-foot project the excavation is comparatively light, but in the 14-foot project it is very heavy over this section, and if the channel is not annually filled with heavy sediment from the Kankakee it will, at least, require constant dredging to maintain it.

The same remarks will apply to other points where there are deep excavated cuts in the river-bed, even with little diminution of velocity of current at floods, but the reach below the mouth of the Kankakee, extending to Marseilles, only will probably present much difficulty; other points to a less degree, as most of the heavier material is brought in by the Kankakee River, and will lodge in the pools below its mouth and above Marseilles Dam.

The water available for lockages throughout the proposed line being in excess of the requirements of the system, no slope is given to the summit level, or provision made for increasing the present discharge of the Illinois River.

For the section of the river under consideration, locks and dams are necessarily employed, and the nearer the system approaches slack-water,

the nearer it approaches the best channel for navigation. As the discharge increases the velocities of the current increase, and finally when the depth of water over the crests of the dams becomes, as the river rises, such as to allow a free discharge, the currents become difficult, or even prohibitory, to up stream navigation, as heretofore stated. The bed of the Illinois River above La Salle at several points being of such steep slope, and its discharge at high water and the variation in its discharge between high and low water so great, seventy to one, it can not be regarded as a very favorable stream for the application of locks and dams. The system fails at high water. Any material increase in the discharge over this section of the river, except at stages near the low water, or below the mid-stage, would be, then, not only undesirable, but objectionable, as far as the interests of navigation are concerned. At all times when the natural discharge of the Illinois River produces a stage obstructive to navigation over the slack-watered reaches, or damaging to property interests, artificially introduced waters should be diminished in quantity to the least effective amount, or entirely cut off.

LOWER ILLINOIS.

Although the Lower Illinois River, from La Salle to the Mississippi River, does not form part of the section of the river ordered surveyed and estimated upon, it forms part of the route from Lake Michigan to the Mississippi River, and everything bearing upon its characteristics in addition to what has already been published is of value in considering the subject of a water-way between the Mississippi River and the Great Lakes. Increased interest is attached to the points herein briefly discussed, in view of the recent laws and joint resolution of the State legislature of Illinois, herewith, relating to a water-way of great capacity, based upon a large discharge from Lake Michigan into the Illinois River.

For this reason the tables of gauge readings at Copperas Creek Dam and La Grange; the discharge observations measured at Peru, La Grange, and Kampsville, as well as those measured at Ottawa, are given herewith.

The questions relating to the Illinois River improvement upon which this data more especially bears are:

(1) At what stage and discharge does the river overflow its banks, or at what stage and discharge will an artificial increase in the discharge of the river begin to produce flowage of lands?

(2) What increased depths in the Illinois correspond to definite increased discharges?

(3) For what length of time, on the average, are the dams on the lower Illinois River necessary for navigation?

(4) When do these dams cease to exercise appreciable influence over slopes, velocities, or current, and flowage of lands?

The discharge observations are not sufficiently extended to give exact determinations of the normal discharge of the river at the various points. The year was one of comparatively low water. Although the dangerous or incipient overflow stage was reached at La Salle and La Grange, and the discharges measured, it was not attained at Kampsville. The low-water stage was not attained at any point, and the mid-stage barely reached.

Observations should be extended over a considerable time to cancel the variations in results due to variations at each stage in the phases of the

waves producing the fluctuations in the river, it being well known that the local slopes and velocities and consequent discharges are greater on a rising than on a falling or stationary river at the same gauge-reading.

Another cause of variation in the results at La Salle is the reservoir action of the pool above the Henry Dam. Upon any little rise in the river during the rainy season while the pool is filling much greater discharges are measured than after the pool is filled, and gradually lowers from the spill over the dam, while the supply that would naturally produce the observed gauge-reading has been materially cut off or reduced by the passage of the temporary rise.

This will account in great measure for the very irregular results at Peru Station. It is believed, however, that the results obtained will give a reasonably close approximation to the truth, which will not be materially changed by more extended measurements.

The discharges measured at La Grange and Kampsville are few in number, but made with care. They were made by Assistant Engineer W. M. Childs, in local charge of the works, at such times as his other duties would allow, the amount allotted for the survey being insufficient to justify the employment of a special party.

The discharges measured at Peru, which are given in full in the appendix to this report, were discussed by the method of least squares, by Mr. C. V. Brainard, the observer at that station, and the following probable discharges at the stages named deduced therefrom. The results are still somewhat irregular.

Reduced discharges at Peru.

[Zero of gauge 0.2 feet below low water of 1888.]

Gauge.	Discharge.
Feet.	*Cubic feet.*
1.00	1,924
1.50	2,883
2.00	3,824
2.50	5,118
3.00	7,066
4.00	8,798
5.00	9,976
6.60	15,855
7.94	*18,108

* Measured discharge at incipient overflow stage.

The low water at Peru has been raised 4.4 feet by the construction of the dam at Henry. The above gauge readings should be increased by that amount to get the approximate heights above original low-water, the zero of the gauge having been placed as nearly as practicable at the extreme low-water mark attained since the construction of the Henry dam.

At La Grange and Kampsville the following discharges were measured, the results given for each stage and date being a mean of from two to four measured discharges. All of the discharges except the low-water discharge in 1887 at La Grange were measured by the use of a Price's current meter and electric register, by measuring mid-depth velocities or by integration. In 1887 the discharge was measured with double floats.

Discharge observations on Illinois River at La Grange Lock, 1887–1890.

[Gauge referred to low water of 1879, Price-current meter in 1888–'89.]

Date.	Gauge.	Mean velocity per second.	Area.	Discharge per second.
	Feet.	*Feet.*	*Sq. feet.*	*Cubic feet.*
Low water, 1887 *	0.00	0.600	2,800	1,685
August 1, 1887	0.20	0.600	2,926	1,760
December 21, 1888	1.98	1.329	3,145	4,178
December 20, 1888	2.00	1.277	3,174	4,054
December 31, 1888	2.95	1.539	3,776	5,811
February 4, 1889	4.33	1.758	4,735	8,322
May 20, 1889	4.40	1.942	4,512	8,765
April 8, 1889	5.01	1.852	5,289	9,796
March 30, 1889	5.85	2.053	5,805	11,924
March 25, 1889	6.72	2.258	6,394	14,439
May 30, 1889	†6.98	2.011	6,214	12,495
March 8, 1889	7.65	2.554	7,208	18,412
April 22, 1889	7.73	2.406	7,132	17,165
March 11, 1889	8.36	2.572	7,664	19,717
July 15, 1889	8.37	1.857	9,901	18,389
June 9, 1889	10.00	2.520	9,813	24,730
July 9, 1889	10.33	2.053	11,990	24,620
January 18, 1890	12.80	2.547	13,069	33,295

* Computed. † Backwater from the Mississippi River.

Discharge observations on the Illinois River at Kampsville, 1889.

[Gauge readings referred to low water of 1879, Price current meter.]

Date.	Gauge.	Mean velocity per second.	Area.	Discharge per second.
	Feet.	*Feet.*	*Sq. feet.*	*Cubic feet.*
April 10, 1889	4.05	1.405	7,312	10,275
April 9, 1889	4.17	1.368	7,345	10,052
April 1, 1889	4.55	1.481	7,770	11,548
July 12, 1889	7.50	2.200	10,859	23,892
June 21, 1889	9.03	2.408	12,901	31,068
June 22, 1889	9.21	2.434	13,084	31,855
May 31, 1889	*10.47	1.470	14,516	21,344

* Backwater from the Mississippi River.

1. OVERFLOW STAGE.

The Lower Illinois partakes more of the nature of an estuary than of a river. Its banks reach only to mid-stage, but are not annually overflowed. Its slope is only 0.15 foot per mile.

The bottom lands which are overflowed at stages above average high water vary in width from a few hundreds of feet to 5 miles, generally densely covered with timber, and cut up by numerous sloughs, lagoons, and ponds. A large area, however, of the higher part of the bottoms is cultivated whenever not submerged before seeding time, and this cultivated area is annually increasing. The gauge readings herewith show the present liability to overflow of this valley.

Throughout the valley of the Illinois it may be said, generally, that at about the 9-foot stage above the low-water mark the bayous and lagoons begin to fill, at 10 to 11 feet the lowest areas, worthless for cultivation, begin to be submerged, and at about the 12-foot stage the overflow begins to become widespread. At about the 16-foot stage probably eight-tenths of all lands submerged at extreme floods are covered with water.

At La Salle, as already stated, the present low water is 4.4 feet above the original low-water stage. Near that point, but below it, the over-

flow begins to be appreciable at about the 7.7 or 8 foot stage above present low water. At Henry, Copperas Creek, and La Grange, at about the 12-foot stage above the low waters of 1871 and 1879, this incipient overflow stage is reached, as may be seen from the discharge observations given above, when the discharge reaches about 18,000 cubic feet per second at La Salle or Peru; about 30,000 cubic feet per second at La Grange, and, estimated, about 40,000 cubic feet per second at Kampsville. The discharge producing overflow on the lower river depends very much upon the stage of the Mississippi River and the temporary slopes of the Illinois.

As already stated, the extreme flood discharge of the Illinois River at Marseilles, Ill., is about 70,000 cubic feet per second. Below that point it receives many large tributaries, and drains a much larger area than above it. The Fox River, the two Vermillions, Big Bureau Creek, Sangamon River, Spoon River, Crooked Creek, the Macoupin River, and many others probably swell its extreme flood discharge at its mouth to from 120,000 to 150,000 cubic feet per second.

It may then be said that the channel of the Lower Illinois without overflow will not discharge one-third of its natural drainage at floods. The impracticability to prevent overflow, then, by such methods as enlarging the channel of the Lower Illinois by the removal of the dams therein and dredging is apparent, when it involves the increase to three times its present capacity of a channel varying in width (not including Lake Peoria) from 600 feet to 1,400 feet, about 14 feet in depth below the crests of the banks, and 225 miles in length from La Salle to the Mississippi River; nor can this channel be increased by the scour of the current over such a gentle slope, this current not in any event exceeding three feet a second due any practicably attainable slope over that part of the river.

2. EFFECTS OF DEFINITE INCREASED DISCHARGE ON CHANNEL DEPTHS.

It will be seen from the appendices to this report that a discharge of from 300,000 to 600,000 cubic feet per minute from Lake Michigan into the Illinois River is contemplated for sanitary purposes by the city of Chicago, and that the United States Government is requested by the Illinois legislature to abandon its adopted system of improvement by slackwater on the Lower Illinois River and attain the same object by means of this increased discharge. The effects of such discharge upon this section of the river, as well as upon the part of the route from La Salle to Lake Michigan, is, then, a proper subject of discussion herein.

Over the unimproved section of the Illinois River, *i. e.*, from Copperas Creek to within a few miles of the mouth of the Illinois, the low-water depths on bars do not exceed from 16 to 18 inches, as reported to this office by pilots and steam-boatmen navigating the river, as well as directly measured by employés of this office in 1887. These bars occupy but a comparatively small proportion of the 137 miles involved, but they establish the present navigable capacity of the stream.

The *natural* low-water volume of the Illinois is gradually diminishing, from various causes, among which may be mentioned the clearing of wooded areas, and almost universal tile drainage and ditching, by means of which the rain-fall is rapidly sent into the river during the wet season of the year, instead of being spread over longer periods, or going to sustain springs that would contribute to the low-water flow.

In 1867 the low water was measured, under General Wilson's direction, below La Salle, and found to be 633 cubic feet per second. In 1879–'80 it was found below Copperas Creek to be 1,566 cubic feet per

second, and in 1887, although the discharge into the Illinois River by the Illinois and Michigan Canal had been materially increased, the low-water volume as far down as La Grange, below the mouth of the Sangamon, was found to be 1,685 cubic feet per second.

This latter measurement seems to indicate that the natural low-water discharge from surface drainage alone of the Illinois River does not exceed 1,000 cubic feet per second within 70 miles of its mouth, after nearly all its principal tributaries have emptied themselves into its channel, the discharge of the Illinois and Michigan Canal being about 700 cubic feet per second.

In considering, then, the effect of the discharge contemplated by the city of Chicago into the Lower Illinois River, we may assume that the minimum discharge of the Illinois River upon the addition of 300,000 cubic feet per minute will be 6,000 cubic feet per second and 11,000 cubic feet per second upon an addition of 600,000 cubic feet per minute.

At La Salle, before the removal of the Henry Dam, 6,000 cubic feet per second will raise the present low-water level about 2.8 feet or maintain a water surface 7.2 feet above original low water. At La Grange it will raise the low-water surface about 3 feet, and at Kampsville (estimated with a mean velocity of 1.4 feet per second) about 2.3 feet.

The larger discharge, 11,000 cubic feet per second, will raise the present low-water surface, under present conditions, about 5.5 feet at La Salle or to 9.9 feet above original low water; about 5.5 feet at La Grange; about 4.5 feet at Kampsville, and about 1.5 feet in the Mississippi at the mouth of the Illinois.

A discharge of 6,000 cubic feet per second would then give a depth over bars on the unimproved river, without dredging, of at least 4.5 feet to La Grange, diminishing to 3.8 feet at Kampsville, and probably not exceeding 3 feet over the lowest bar on the river.

This discharge would not do away with the necessity for locks and dams for an ample channel or for channel works or dredging for a more restricted channel.

The larger discharge would give a depth over bars of at least 7 feet to La Grange, already nearly secured since the opening to navigation of the La Grange Lock (the dredging in the pools only remaining to be done from La Grange to La Salle at a comparatively insignificant cost), which depth would diminish to about 6 feet over the bars near Kampsville, and to not exceeding 5 or 5½ feet over the lowest bars on the Illinois River. Greater depths over bars between Kampsville and La Grange will be obtained by the completion of the Kampsville Lock and Dam and dredging crests of bars, at an estimated cost of less than $200,000 for this pool.

The increased discharge on account of the benefits to navigation stated above would be desirable only during the low-water stages, but the discharge is proposed to be constant, whether it be beneficial or harmful.

Upon the completion of the present project for the improvement of the Lower Illinois, now near at hand, any material benefit due to an increased discharge of 300,000 cubic feet per minute in the rivers from Lake Michigan to the mouth of the Illinois will be confined to the short stretch of 31 miles from the Kampsville Dam to the Mississippi River. The largest discharge may make a substitution of an open-river navigation throughout the lower river for a slackwater improvement practicable, but the latter system is already on the point of attainment and paid for within 20 per cent. of its ultimate cost. Even this large discharge wil not do away with the necessity for dredging through bars to obtain 7 feet at low water from La Grange Lock to the Mississippi River, 79 miles distant.

3. LENGTH OF TIME ON AN AVERAGE THAT THE DAMS ON THE ILLINOIS RIVER ARE NECESSARY FOR NAVIGATION.

Upon the Lower Illinois, between La Salle and the Mississippi River, three dams have been built, viz: At Henry, Ill., 196 miles; at Copperas Creek, 137 miles; and at La Grange, 79 miles above the mouth of the Illinois. A fourth dam is contemplated at Kampsville, 31 miles from the Mississippi, which will complete the series.

The discharge of the Illinois River at low water is so small that it is impossible without locks and dams to secure satisfactory width and depth of channel by dredging and wing-dams under present conditions. At all stages, however, more than 2 feet above low water it is practicable by dredging to maintain, as at present, a channel 6 feet deep above Copperas Creek and 7 feet below that point without the aid of wing-dams, by simply making cuts through bars, for comparatively short distances, of the requisite width, and not exceeding at the shoalest points 3½ feet deep. By the aid of dredging, therefore, the dams may be considered unnecessary at all stages higher than 2 feet above the low water of 1879. The gauge records upon the unimproved river below Copperas Creek Lock and at La Grange, give the following results:

COPPERAS CREEK, LOWER GAUGE, 1879–'89, INCLUSIVE.

Annual periods during which the Illinois River was at a stage below 2 feet above extreme low water of 1879.

Year.	Months.	Days.	Year.	Months.	Days.
1879	2	24	1886	1	22
1880	2	23	1887	2	24
1881	2	9	1888	1	10
1882	0	0	1889	1	0
1883	0	21			
1884	0	13	Annual mean	1	12
1885	0	0			

LA GRANGE, ILL., 1883–'89, INCLUSIVE.

Annual periods during which the Illinois River was at a stage below 2 feet above low water of 1879.

1883	1	1	1888	3	5
1884	0	13	1889	1	14
1885	0	0			
1886	2	8	Annual mean	2	10
1887	6	1			

By the aid of dredging, therefore, the dams on the Illinois River are *necessary* for navigation an average period of two months and ten days.

Without the aid of dredging or channel improvements, and in the present condition of its bars on the Lower Illinois River, *i. e.*, with minimum depths of 18 inches, the dams are necessary for longer periods than the above.

Below the mouth of the Illinois and above St. Louis, the minimum depths on bars do not now exceed 5 feet at low water. The United States Engineers, under annual appropriations, seek to maintain 6 feet at low water. If we then consider 6 feet as the least allowable depth of navigation *necessary* in the Illinois, the following tables will show the annual periods and mean annual period that these dams may be considered necessary without channel works.

Table showing annual periods with "less than 6 feet of water" in the Illinois River channel (low water over bars being assumed at 18 inches).

BELOW COPPERAS CREEK LOCK, FROM 1879 TO 1889, INCLUSIVE.

Year.	Months.	Days.	Year.	Months.	Days.
1879	7	7	1886	5	26
1880	4	29	1887	7	20
1881	3	6	1888	5	0
1882	2	29	1889	6	4
1883	2	25			
1884	1	13	Average per annum	4	11
1885	0	21			

BELOW LA GRANGE LOCK, 1883 TO 1889, INCLUSIVE.

1883	2	21	1888	5	2
1884	1	12	1889	6	6
1885	0	14			
1886	6	0	Annual mean	4	11
1887	8	20			

4. INFLUENCE OF THE DAMS UPON FLOOD HEIGHTS AND UPON FLOWAGE OF LANDS.

As already stated, incipient overflow occurs at about the 12-foot stage; between 12 and 16 feet above low water the greater part of lands subject to overflow on the lower Illinois River become submerged, but the extreme floods reach from 21 to 27 feet above low water at different points along the river from La Salle to Kampsville. Below La Grange the high-water stage is determined by the Mississippi floods, and to a less extent above that point also. The pools in the Illinois River slack-water system are of the following lengths: That created by the Henry Dam, 29 miles to La Salle; the Copperas Creek Pool, 59 miles; the La Grange Pool, 58 miles; and the pool to be created by the Kampsville Dam, 48 miles. If we consider that a modification of the original slopes of less than .01 of a foot to the mile, and that a cumulative increase of heights of water services not exceeding that amount per mile is not appreciable in effect, we may say that, as long as the falls or slopes over the dams are less than 0.3 of a foot at Henry, 0.5 of a foot at Copperas Creek, and 0.5 of a foot at La Grange, these dams practically cease to control the heights of water surfaces, slopes, and velocities of current or to increase damages by flowage of lands.

With reference to the Henry Dam, the collector of the board of canal commissioners of the State of Illinois, Mr. Duncan Campbell, furnishes the following information:

After a careful examination of the record made by the river during the last ten years, I find it to be 10.5 feet above low water of 1871, at which time and stage there will be a flow over the dam 4.2 feet deep, with a fall of 0.2 of a foot. This stage and condition of the river would admit of boats passing over the dam drawing nearly 4.2 feet. There is abundant evidence that any volume of water above 4.1 feet over the dam will produce the equilibrium between the pools to a fall of about 0.2 of a foot or less, and any supply below that stage only at a *much greater fall.*

There occurs, however, another condition of the river, which, to be understood, may be called a *falling equilibrium,* in which case the subsidence in both pools is coincident; but if the upper one ceases to fall, the lower pool still continues to a lower level, producing the greater fall, already alluded to, with a less flow than 4.2 feet over the dam.

This equal fall of the pools sometimes continues down to 2 feet over the coping of

the dam with a fall of 0.2 of a foot; at which time a boat drawing 1.20 feet could pass over the dam.

Two feet over the dam is the lowest falling equilibrium with 0.2 of a foot fall.

Four and two-tenths feet over the dam is the lowest stage that can produce and maintain that equilibrium with a fall of 0.2 of a foot.

The dam at Henry is, then, practically drowned out at from 8.3 to 10.5 feet above low water of 1871.

For Copperas Creek Dam we have the gauge-readings attached to this report and also a hydrograph, which shows at a glance the relations of the pools above the dam to the water surface of the river below before the construction of the La Grange Dam, 58 miles lower down the river. The following table has been prepared from these gauge-readings:

Table showing the lowest stage above low water, as indicated by the lower gauge at Copperas Creek Lock, at which the fall in the water-level between the upper gauge (A) and the lower (No. 1), about 400 feet apart, is reduced to 0.5 foot, and also the period each year that the fall is 0.5 foot or less.

Year.	*At Gauge A.	At Gauge 1.	Period with 0.5 foot (or less) of fall.	
			Months.	Days.
1879	3.90	9.35	1	17
1880	3.35	8.60	5	25
1881	2.70	8.10	5	6
1882	3.00	8.40	7	2
1883	2.55	7.95	7	6
1884	2.30	7.60	4	22
1885	2.75	8.30	4	28
1886	2.40	7.95	0	22
1887	2.90	8.25	2	17
1888	1.85	7.20	4	15
1889	3.20	8.60	1	17
Averages	2.81	8.21	4	5
Lowest stage	1.85	7.20	.....	.....

* Readings in this column have reference to "crest of dam."

At Copperas Creek, therefore, at an average stage of 8.21 feet above low water of 1879, as measured upon the lower gauge, the fall over the dam is reduced to 0.5 of a foot, and to a less fall at higher stages, and that this practical drowning out of this dam continues on the average for four months of the year.

The La Grange Dam has just been completed, but the present mid-stage of the Illinois shows that that dam, before the construction of the Kampsville Dam, and while the Upper Mississippi is at a low stage, is drowned out at 12.5 feet above extreme low water of 1879. Doubtless it will average a still lower stage in years when normal relations exist between the Illinois and Mississippi Rivers, or after the construction of the Kampsville Dam, which will modify the slopes of the Illinois at mid-stage, independent of the lower stages of the Mississippi River.

All of the dams on the Illinois River, then, are drowned out before the overflow stage is reached, and, consequently, have little or no influence in causing flowage of the bottom lands. None of them modify the currents at stages when the deterioration of rivers is usually a maxium, nor hinder in any way the scouring out of the pools above them at such stages of the river when the velocities are a maximum and most effective.

A prejudice exists, however, which has been persistently fanned and cultivated during the past two or three years, against these dams, and

the removal of the State dams at Henry and Copperas Creeks has been ordered by the State legislature of Illinois, in any event, after four years from July 1, 1889, and earlier, under certain conditions.

These dams are necessary for navigation for several months each year, and the unreasonable objections to them, lately developed, could be easily removed at comparatively small expense, by making them movable, to be thrown down when not absolutely necessary.

All of the dams on the Illinois River for facilitating towing and rafting should be of the movable class, undoubtedly, as for eight months in the year they are not necessary, and for half that time not sufficiently submerged to allow loaded boats to pass over them.

It is to be hoped that the United States Government, having constructed the foundation of the Copperas Creeks Lock, and expended funds in dredging and deepening the pools formed by the dams, and secured the right of transportation free of tolls for its property and troops over this route, may have sufficient rights and interests involved in the matter to prevent the removal and destruction of these necessary works at Henry and Copperas Creeks until some equivalent means of establishing and maintaining navigation over this public highway at low stage are actually substituted.

CHICAGO DRAINAGE AND WATER-WAY LAWS.

Up to the present time the improvement of the Illinois River has proceeded upon the strict national basis of the requirements of navigation, and as late as 1887, no reason for any increase in the dimensions of the channel proposed for this improvement and in course of execution on the Lower Illinois had been developed. The Illinois legislature at its session in 1887 passed an act of cession, ceding to the United States the State works occupying part of the line, upon the condition that the United States should carry the improvement through from the Mississippi River to Lake Michigan on a basis of 7 feet depth of navigation, but in 1887, also, the commission of experts employed by the city of Chicago to examine into and report upon the best plan for drainage and water-supply submitted its preliminary report, which contains the first official demand from any source for a navigable channel of *great discharging capacity* several times the depth necessary for navigation across the Chicago Divide, and is the origin and basis of the present requests of the legislature of Illinois for the construction by the United States Government of a water-way 160 feet wide and 22 feet deep across the Chicago Divide as far as to Lake Joliet, and for a channel 14 feet deep thence to La Salle, the former act of cession of the State works at the same session being repealed.

We now find this proposed route, instead of being urged upon a purely national basis encumbered with conditions that have no relation whatever to any national ends or objects, but purely dependent upon local necessities for sewerage and water-supply as the real governing basis, while a great water-way is urged as a national necessity to secure United States aid.

With reference to the "Chicago drainage and water-way laws," a few remarks may be found in the Annual Report of the Chief of Engineers for 1889, page 2130 *et sequitur*, to which reference is here made. These remarks are supplemented and made more clear by this report.

No channel as deep as 22 feet has yet been constructed upon the Great Lakes, nor have any of the harbors on the Great Lakes been constructed of that depth. The entrance to the harbor of Chicago, which exceeds any port of the United States in number of arrivals and depart-

ures of vessels, is only 16 feet in depth below low-water in Lake Michigan. At the Mississippi terminus of the line there exists less than 6 feet at low water.

Granting the necessity for a channel-way of large capacity across the Chicago Divide, a narrow and deep channel with a more or less rapid current is not of the character demanded by Western river navigation. The heavy business of these rivers, especially of the Mississippi and Ohio, is transacted by barges and tow-boats, or by wide flat-bottomed steam-boats of comparatively light draught. If any channel, therefore, of materially greater capacity than the minimum herein estimated for be constructed by the United States Government across the Chicago Divide, it would be infinitely better for purposes of commerce and navigation that it should be doubled or trebled in width, with the locks suitably increased in span and length to accommodate powerful tow-boats with their full tows than that it should be restricted in width and made so deep, with a more or less obstructive current therein.

No one cognizant of the necessities of the city of Chicago for better drainage and a purer water-supply can fail to sympathize with her efforts to arrive at a solution of the problem, and as both the channel for drainage and the channel for navigation across the Chicago Divide must necessarily occupy the same field, it is manifestly the duty of the General Government, to prevent unnecessary expenditure, in planning its works to so construct them that while subserving strictly the necessities of the public generally, that they shall conduce also, as much as possible, to the health, comfort, and general welfare of the special locality. It is not so clear, however, that these works should be constructed of greater capacity, or at materially greater expense to the National Treasury, than demanded by national interests, for the purpose of meeting purely local necessities, when these necessities have not arisen from any act of the General Government.

If, then, the capacity of the channel required by national interests should be first definitely decided upon, and the work be constructed by the General Government in accordance with this decision, across the rock up-lift at Lemont, and the city of Chicago be then allowed to avail herself, under proper conditions, of this work by enlarging and deepening such parts of it as are necessary for her purposes, it would detract but little from its value as a navigable channel due the introduction of a current into an otherwise slack-water canal, over such a short portion of the route, while saving at the same time probably 50 to 60 per cent. of the cost of this most expensive part of her drainage canal to the city of Chicago.

Such a solution would seem just and proper, provided that, if the United States should be held responsible for flowage damages along the Illinois River due the water thus artificially introduced into the rivers through its channel, they should be allowed to control the discharge of the canal thus constructed for such periods as it might cause overflows and damage, and possible great obstruction to navigation in the river below that would not occur without this addition.

As shown in this report, the overflow stage is reached near La Salle at about 7.5 to 8 feet above present low water, at a discharge of 18,000 cubic feet per second; at La Grange at a discharge of about 30,000 cubic feet per second; at Kampsville at a discharge of about 40,000 cubic feet per second, but when the Mississippi is high, at a much less discharge. Upon the Upper Illinois there is no data to determine at what stage and discharge an introduction of an artificial discharge would cause damage.

This artificial discharge is not *necessary* for navigation anywhere along the line, and can not be said to *benefit* navigation anywhere to such an extent as to justify the United States Government assuming responsibility for flowage damage caused by it.

The discharge is proposed to be constant, whereas if it were produced by the United States for the benefit of navigation it would be introduced into the Illinois only at low stages, when it would be beneficial to navigation and harmless to property.

Now, at any little summer freshet, producing a discharge exceeding 8,000 cubic feet per second at La Salle, damage by overflow would begin at that point, the artificial discharge being 10,000 cubic feet per second, and with greater natural discharge become more and more widespread as we progress down stream, at times when such overflows would not otherwise occur. Upon all rises of the river producing anywhere near bank-full stages this artificial discharge would cause flowage damages that would not otherwise occur. The lands would become submerged at high water earlier and the water remain upon them longer that it otherwise would. From 100,000 to 300,000 acres of lands in the Illinois River valley will be subject to such conditions.

* * * * * * *

That feature, therefore, in the Chicago drainage and water-way laws that requires a *constant discharge* of from 300,000 to 600,000 cubic feet per minute seems, in view of past experience, decidedly objectionable if the water is to be introduced through any canal either owned or used by the United States for public purposes if by such ownership or use the United States can be made responsible for damages due to such constant discharge.

There is nothing perfect under the sun, and doubtless the city of Chicago could find a reasonably satisfactory solution, and a cheaper one, although not by any means a perfect one, of its sewage question by looking somewhat to the natural water-shed of the Illinois to furnish some of the water required by the law for the dilution to inoffensiveness of its sewage by sending into the Illinois River a variable quantity of Lake Michigan water, depending upon the state of that stream, *all* required by the law when it can safely be done, *less* than this when it can not, and upon exceptional floods, the inconveniences of which all should share, suffer with the Illinois valley some of the discomfort attendant upon such conditions. Such would be the modifications that control over the artificial discharge into the Illinois River would produce.

These are matters of detail that doubtless can be remedied by subsequent legislation.

By properly guarding and limiting the liability of the United States for flowage damages due water not necessary for navigation, but introduced either through United States channels or over United States dams, doubtless a satisfactory arrangement may be made by which this great city could profit by the necessary United States works, while the United States would not be put to unnecessary expense.

As the State law stands, however, demanding a constant discharge and unnecessarily great and expensive channels not demanded or suitable for the commerce to be subserved, a compliance with its terms do not seem advisable for the United States.

In view of these facts and laws the necessity for a thorough survey from Joliet to the Mississippi River, at least with the detail shown on the maps of the present survey, *i. e.*, with accurately determined contours at every foot elevation of surface, and with the areas of lands

subject to overflow well determined, should be made by authority of Congress before any artificial discharge whatever is turned into the Illinois River, to determine the effects of such artificial discharge and the areas of lands that may be subject under any conditions to flowage thereby. Such a survey would cost, probably, $250,000, but ultimately save many times that amount to the organization held responsible for such flowage damages, whether it be the Government of the United States or the city of Chicago.

COMMERCIAL ADVANTAGES.

This route has invited attention as a practicable locus for a water-way between the Great Lakes and Mississippi River for many years, and its advantages have been so often reported to Congress that anything herein said would be mere repetition. It is sufficient to say that the minimum channel herein estimated upon will open a channel of commerce with a maximum annual capacity of 29,000,000 tons between the Great Lakes, with its terminus at their greatest port, and a system of navigable rivers penetrating one-half of the States and Territories of the Union, with a total navigable length equal to more than half the circumference of the globe.

In the meantime attention is invited to the following reports hitherto submitted to Congress:

General J. H. Wilson, 1867, House Ex. Doc. No. 16, Fortieth Congress, first session.

Colonel Macomb, Corps of Engineers, Report of the Chief of Engineers, 1875, volume 2, page 525.

Maj. G. J. Lydecker, Reps. Chief of Engineers, 1879, page 1572; 1880, page 1995.

Maj. W. H. Benyaurd, Report of the Chief of Engineers, 1884, page 1958.

Maj. Thos. H. Handbury, Report Chief of Engineers, 1887, page 2119.

Report of the Board of Engineers on Hennepin Canal, 1887, Report of the Chief of Engineers, 1887, page 2125.

Respectfully submitted.

W. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., August 27, 1888.

CAPTAIN: Referring to the surveys, plans, and estimates for a navigable water-way between Lake Michigan and the Mississippi River via Lockport, La Salle, and the Illinois River, it is expected, of course, that your report will cover the route which, in your judgment, is the most economical and advantageous for the United States, and best suited to subserve the ends in view. Should the route thus selected cause the proposed water-way to debouch into the lake within the limits of the city of Chicago, well and good. If not, the Chief of Engineers directs that you report upon an alternative termination which will so debouch. The report on such alternative debouch, while, of course, to be embodied in and form part of the general report, should be distinct and unified, so as to be studied by itself, and should be sufficiently detailed to enable the Chief of Engineers to form a definite and conclusive opinion as to its merits regarded from the stand-point of the commercial and sanitary interests of Chicago.

By command of Brigadier-General Casey:

Very respectfully, your obedient servant,

CLINTON B. SEARS,
Captain of Engineers.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. Army.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., May 1, 1889.

GENERAL: The survey ordered by Congress in the river and harbor act of August 11, 1888, item Illinois River, for a water-way of large dimensions (14 feet depth, 160 feet width), across the Chicago Divide to Lockport, thence via the channel of the Des Plaines and Illinois rivers to La Salle, has now arrived at the point that allows the estimates of quantities of excavation, etc., and cost of the cut across the divide to be begun.

As the Department is aware, local necessities, as determined after examination by a commission of experts employed by the city of Chicago, demand a large discharge from Lake Michigan into the Illinois River for sanitary reasons. Navigation interests not only do not demand increased discharge for the Illinois River, but also in so far as an increased discharge introduces into an otherwise slackwater system a current that increases the cost and the difficulties of navigation in some proportion to the square of its velocity, would be positively injured thereby to the extent of the obstruction.

A navigable channel, therefore, demands no slope to the costly cut through the Chicago Divide. Local sanitary necessities demand a slope of not less than 4 inches to the mile, and a cut consequently deeper by from about 7 feet to about 11 feet, in rock, throughout about 12 miles, more or less, of the canal at the divide, at a probable increased cost of about $60,000 per mile per foot depth, and for about 15 miles, more or less, an increased depth of cut, in earth, varying from 3 to 7 feet in depth, at a probable increased expense of about $15,000 per mile per foot increased depth. In this case, also, the works below must be designed to provide for passing, at increased cost, the increased discharge.

The data accumulated by the survey is sufficient for estimating a water-way with any practicable slope and discharge consistent with reasonably easy navigation, 14 feet in depth; but, probably, not sufficient to estimate a channel of the extreme slope and discharge capacity required by Chicago.

I have to respectfully ask instructions from the Department whether it is the desire of the Department that the estimates demanded by Congress shall be rendered on the basis of the requirements of navigation for the best channel for navigation, or whether the local drainage problem shall also be considered, or separate estimates made under each condition?

It is my desire to comply with the intent of the act, even if it involves the duty of touching upon purely local questions of sanitary engineering, still a matter of local discussion and dispute, but I am uncertain whether the elimination by amendment from the act passed of all mention of the *discharge* or capacity for discharge of the proposed channel, which was originally a feature of the bill, was intended to intimate that only estimates and plans for the channel, 14 feet deep, best adapted for navigation are desired by Congress, *i. e.*, that national interests only are to be presented officially by United States officers and the local necessities be presented to Congress, if at all, by the petitions of localities interested, or by their representatives in Congress, or whether the terms "not less than 14 feet in depth," taken in connection with the well-known capacities for navigation of the Illinois and Mississippi rivers, was intended as equivalent to a direction to regard not only the interests of navigation which require no such depth of channel as the minimum indicated, but also other interests that, though purely local, may require the execution of such a scheme, if approved by the people of the locality, *i. e.*, whether it is not the intent of the act that the United States officers shall make estimates and plans for local engineering projects not yet put in form for execution, nor yet authorized by State law, nor even accepted yet by local vote, making the interests of navigation not paramount but subsidiary thereof.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through the Division Engineer of the Northwest Division.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., May 3, 1889.

Respectfully returned to Captain Marshall, with suggestion that he present his own views upon this question, and submit a definite proposition for carrying them into effect.

O. M. POE,
Colonel of Engineers, Engineer Northwest Division.

[Second indorsement.]

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., May 4, 1889.

Respectfully returned to the Engineer of the Northwest Division, with letter of this date addressed to the Chief of Engineers, U. S. Army, submitted in compliance with suggestion contained in the above indorsement.

W. L. MARSHALL,
Captain of Engineers.

UNITED STATES ENGINEER OFFICE,
Chicago, May 4, 1889.

GENERAL: In accordance with the suggestion of the engineer of the Northwest Division in indorsement of the 3d instant, on my letter of the 1st instant herewith, I have the honor to submit the following:

The act in question reads—

(1) "And for the purpose of securing a continuous navigable water-way between Lake Michigan and the Mississippi River, having capacity and facilities for the passage of the largest Mississippi River steam-boats and of naval vessels in time of war, the Secretary of War is authorized and directed to cause to be made the proper surveys, plans, and estimates for a channel improvement and locks and dams in the beds of the Illinois and Des Plaines Rivers from La Salle to Lockport.

(2) "so as to provide a navigable water-way not less than 160 feet wide and not less than 14 feet deep.

(1) "and to have surveyed and located a channel from Lockport to Lake Michigan at or near the city of Chicago, such channel to be suitable to the purposes aforesaid." * * *

The purpose of the act is definitely stated to be to secure a navigable water-way capable of passing the largest Mississippi River steam-boats and naval vessels in time of war; but the act does not allow the capacity of the channel to be determined by the consideration of the size and draught of Mississippi River steam-boats that can reach the mouth of the Illinois River, but prescribes the minimum dimensions of the required channel, which minimum, as far as depth is concerned, is more than twice the depth of hold of the largest steamer, viz, the *St. Paul*, 804 tons, 6 feet 2 inches depth of hold, 300 feet long, that navigates the Mississippi River above St. Louis, and is nearly 60 per cent. greater than the depth of hold, 9 feet, of the largest side-wheel Anchor Line steamer navigating the Mississippi River.

The item (2) in the river and harbor bill was written, as he himself informed me, by Judge Hurd, a member of the Citizens' Drainage Committee of the city of Chicago, in lieu of the provisions of the original bill prescribing large discharge capacity for the proposed channel which could not be passed, being plainly dictated in the interests of local sanitary measures.

The low-water navigation of the Mississippi, should the millions of dollars estimated to secure these depths be successfully expended (at present rates of appropriation from twenty to forty years hence), will be, from the mouth of the Illinois to St. Louis, 6 feet; from St. Louis to the mouth of the Ohio, 8 feet; from the mouth of the Ohio to the head of the passes, 10 feet. At present the low-water depths are from 18 inches to 3 feet less than the above depths throughout.

As all steamers which navigate the Mississippi River, as well as all naval vessels which will at any time promenade the Western rivers, to be useful and profitable will be built adapted to the ordinary conditions which limit navigation, it can not be seen why the national requirements (1) of the act of August 11, 1888, would not be fully met by limiting the expenditure for improving the Illinois River to what is necessary to secure a good navigable channel 8 feet in depth between Lake Michigan and the Mississippi; indeed, 7 feet upon bars and upon miter sills at extreme low water would seem to fully meet all present or future requirements, and it is upon the latter basis that work upon the locking and damming the Lower Illinois River has been carried on for the past fifteen years. This, too (7 feet), is about the limit of possible low-water improvement of that part of the river at reasonable expense. As already stated, the part of the act marked (2) is in the interest of local sanitary schemes. The channel for navigation and the channel for drainage both lead from Lake Michigan to the Illinois River, and the larger the cut made by the United States the less will be the expenditure required by the city of Chicago to drain the city.

The question of improving the Lower Illinois River by means of using Lake Michigan as a reservoir was considered by the first Board of Engineers that examined generally the navigation of the Illinois, of which Board General J. H. Wilson, U. S. Army, and William Gooding, civil engineer, were members, and who reported December 17, 1867. This plan was rejected on account of its expense. * * *

From discharge observations just made at La Grange and Kampsville on the Illinois River it is seen that the maximum discharge proposed by the city of Chicago—10,000 cubic feet a second—will fail to produce a depth of 7 feet in the Lower Illinois, which is now near being attained by locks and dams, while the discharge at the same time will necessarily introduce into the canal, 36 miles long across the divide, a current that would, taken in connection with the lack of steerage way in a restricted canal 160 feet wide, materially obstruct navigation.

Inasmuch as a depth of navigation greater than can be attained by the largest discharge from Lake Michigan yet proposed, is already upon the point of attainment by locks and dams at much less expense throughout the Lower Illinois (225 miles out of 326 miles), and inasmuch as the remainder of the line, viz, from La Salle to Lake Michigan, on account of the difference in level (142 feet) must necessarily involve the use of locks and dams, and the supply of water is at present sufficient for the service of the system, I can see no reason why any time or money should be expended by the United States in making surveys, estimates, and plans looking to a large discharge from the Great Lakes into the Illinois River.

When such a scheme for sanitary purposes has been authorized by State law; when it shall have been adopted by the people of this city, and when definite plans for the work are under execution, or at least in shape to be understood, it seems to me that it will be a proper time for United States officers having in charge the works of navigation along the Illinois River line, to plan for taking care of this increased discharge; or, when the United States Government introduces into the Illinois River noxious matters, it will be then time for its officers to take steps to abate the nuisance at public expense.

Meanwhile, it is my opinion that all surveys, plans, and estimates should be made upon the basis of the best channel for navigation, and that local necessities, while they should very properly affect the *location* of the channel, should not be allowed to materially increase its expense to the United States, by requiring its capacity increased by the United States beyond what national interests require, and that the channels, estimated by United States officers, should not be devised to meet local needs not arising from any act of the General Government. If navigable channels require modification to make them adapted to local drainage, the plan should be made by engineers under local direction, and the modifications made at local expense, if authorized by Congress.

In the present instance the *demands of navigation* require 8 feet at low water, or 10 feet across the divide at mean stage, in Lake Michigan. The *law* requires estimates for a 14-foot channel-way. The *city of Chicago* requires from 18 to 22 feet *with a slope of one-third foot per mile across the divide*, and a large discharge, while the United States Government, under river and harbor acts, is laboring to obtain from 6 feet to 10 feet low-water navigation in the Illinois and Mississippi rivers, from La Salle to the Gulf of Mexico.

I desire to make the estimates required by law wholly from the stand-point of the interests of navigation, for a 14-foot channel, as required by the law, and for an 8-foot channel also, as required for steamers navigating the Western rivers, leaving the modification of the channel that may be required by local sanitary necessities to be attended to by the local authorities to suit themselves; but as I am uncertain as to the intent of the law, or as to its interpretation by the Department, I have considered best to seek the instructions of the Department in the matter.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through the Division Engineer of the Northwest Division.)

[Third indorsement.]

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., May 8, 1889.

Respectfully forwarded to the office of the Chief of Engineers, with the following remarks, viz:

It seems clear to me that the act of August 11, 1888, requires that "the proper surveys, plans, and estimates for a channel improvement, and locks and dams in the beds of the Illinois and Des Plaines rivers from La Salle to Lockport so as to provide a navigable water-way not less than 160 feet wide and not less than 14 feet deep" be made; "also, that there be surveyed and located a channel from Lockport to Lake Michigan at or near the city of Chicago, such channel to be suitable to the purposes aforesaid."

* * * * * * *

The "purposes aforesaid" are the "securing a continuous navigable water-way between Lake Michigan and the Mississippi River, having a capacity and facilities ade-

quate for the passage of the largest Mississippi River steam-boats, and of naval vessels suitable for defense in time of war." * * *

It does not appear that the project for a 14-foot channel must necessarily cover the whole distance from Lake Michigan to the Mississippi River, but *may* be limited to the portion between La Salle and Lockport. The only requirement imposed by the law for the remainder is that it shall provide for a channel having capacity and facilities adequate "for the passage of the largest Mississippi River steam-boats and of naval vessels suitable for defense in time of war."

* * * * * * *

O. M. POE,
Colonel of Engineers, Engineer Northwest Division.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS, U. S. ARMY,
May 14, 1889.

Respectfully returned to Captain Marshall, through the division engineer, northwest division.

The views of Captain Marshall in his communication of May 4, also herewith returned, are concurred in by the Chief of Engineers. Surveys, plans, and estimates for a 14-foot channel as required by law and for the 8-foot channel required by Western river-boats should be made in the interest of navigation.

Modifications required to adapt to local wants the navigable channels thus surveyed should be left to local authorities.

To be returned.

By command of Brigadier-General Casey:

H. M. ADAMS,
Major, Corps of Engineers.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., January 22, 1890.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.:

CAPTAIN: I have the honor to submit the following report upon surveys and estimates for proposed water-way between Lake Michigan and Mississippi River called for by act of Congress August 11, 1888:

The act calls for estimates for that portion lying between Lake Michigan and La Salle, Ill., and restricts the location between La Salle and Lockport to the beds of the Illinois and Des Plaines rivers. From Lockport to Sag Bridge the topography restricts the location to the valley of the Des Plaines River. From Sag Bridge to Lake Michigan two main routes are feasible, and each of these routes in part of its length permits some choice as to location. The first of these routes follows the Des Plaines Valley from Sag Bridge to Summit, thence across a low prairie to the south branch of the Chicago River at Bridgeport and thence by the Chicago River to Lake Michigan. The second route goes nearly due east from Sag Bridge through a break in the hills bordering the Des Plaines Valley, enters the Little Calumet River near Blue Island, and reaches Lake Michigan through the Grand Calumet River at South Chicago. Along the first of these routes was constructed the Illinois and Michigan Canal, and along the second was constructed the Calumet feeder to supply the canal with water from the Little Calumet River. The low break in the hills east of Sag Bridge and the marshy area still further east is known locally as "The Sag." For convenience of reference in this report the first of these routes will be called the Chicago route, and the second the Sag route. The second is known also as the Feeder route.

CHICAGO ROUTE.

The Chicago River is formed at 7,000 feet from Lake Michigan by the junction of two sluggish streams known as the North Branch and South Branch of Chicago River. The general direction of these streams is shown on the map accompanying this report. They divide the city into three divisions, known as the North, West and South sides. In the area on the South Side, north of Twelfth street, is situated the business center of the city of Chicago, and to and from this area the city's daily tide ebbs and flows. To this area converge the lines of street railways and the heavy street traffic.

Commencing at Lake Michigan, the Chicago route follows the Chicago River to the junction of its two branches, thence along the South Branch to Bridgeport. From

the lake to Madison street the river exceeds 160 feet in width. Above Madison street for a considerable portion of the distance it is less than 160 feet wide, and in the whole distance very crooked. The river is spanned by twenty-four bridges, some being of the largest and costliest type. A list of these bridges and their dimensions accompany this report.

The traffic over the bridges in the central portion of the city is enormous, and the opening of one of them interrupts street traffic for blocks away. The river is thronged with lake craft of all kinds both day and night, and the bridges require to be constantly on the swing to permit their passage. At certain hours of the day, however, the pressure of street traffic becomes so great that the bridges are not opened at all, and vessels must wait at their docks or in the harbor until the bridges can be opened. The effort has been made to keep pace with the increase in street traffic by building wider bridges capable of being more quickly opened and closed. Even such bridges costing from $130,000 to $150,000, can only with difficulty and the most careful police control carry the great streams of people and vehicles safely over them. It is evident that in so narrow a river a limit to the width of the bridges is soon reached. In order to overcome this difficulty two of the more recent bridges have been built with center piers at one side of the center of the river, the bridge swinging partly over land and leaving but one opening for the passage of vessels. The opening between center pier and west dock line has been entirely closed.

Two tunnels have been constructed under the river, one at La Salle street connecting the North and South sides; the other at Washington street connecting the South and West sides. Both these tunnels have passed into the control of a street railway company for carrying cable lines under the river. While they very materially assist in passing the stream of people by the river they do not assist the movement of the multitude of vehicles.

The banks of the river are lined with valuable buildings of the most permanent construction; with large grain elevators, with railroad passenger and freight depots and yards, with immense lumber, ore, and coal docks, and with warehouses, mills, and the various industries of a great metropolis. The river is not controlled by the General Government, not having been improved by it, but has been improved by the city and by private parties, and is controlled by the city. A vessel dispatcher controls the movements of vessels and bridges. A tabular statement of the movements of vessels and operation of bridges taken from the annual report of the vessel dispatcher for the year 1888 is given herewith.

In order to make a water-way 160 feet wide through the Chicago River to Bridgeport suitable for Mississippi River steam-boats it would be necessary to reconstruct twenty bridges, at an estimated cost of $2,250,000, and to acquire 325,000 square feet of ground, the estimated value of which is $450,000, and to construct 11,500 linear feet of new dock, at an estimated cost of $172,500. To these amounts would have to be added $165,000 for excavation, and a large amount for land damages, which it would be impossible to estimate.

It would seem that the present congested and crowded condition of the streets and river, and the excessive cost, would forbid this route as an outlet to the lake, but the instructions required that an estimate should be submitted for a route which should enter Lake Michigan within the city limits of Chicago. At that time Thirty-ninth street was the southern limit, and the proposed route must enter the lake north of that street. Other plans for getting from Bridgeport to the lake than by the river have been considered, but none found less objectionable. One project that has found some advocates is to dig the channel just north of Thirty-ninth street. To show that this line is not a feasible one it is only necessary to state that it would cross forty streets, twenty of which are principal thoroughfares; six lines of street railways, making about ten thousand eight hundred single-car trips daily north of Thirty-ninth street, and about four thousand seven hundred south of that street; and twenty-two railroad lines, running two hundred and eight suburban and one hundred and eighty-two passenger trains daily, with the necessary freight trains. Over the Illinois Central tracks alone one hundred and forty-two passenger and suburban trains cross that line daily.

The land necessary to be taken on this line, with the costly improvements thereon, is worth probably not less than $7,000,000, while damages to adjacent property would probably reach a like sum. If to these items be added the cost of bridges or tunnels, and the cost of construction of a work of the proposed dimensions in a crowded city, the amount reaches figures putting that route out of the question. The same objections as to interruption of established lines of communication, and as to cost, obtain against any other line between Thirty-ninth street and the mouth of Chicago River. The South Branch at Bridgeport is formed by the junction of two bayous, one coming from the south and one from the southwest, known as the South and West forks of the South Branch. The South Fork has been made navigable as far as Thirty-ninth street, and private parties are making it navigable west from that point. South of Thirty-ninth street are situated the Union Stock Yards and the immense

slaughtering houses and kindred establishments surrounding them. The West Fork is also navigable some distance from Bridgeport.

Starting from Bridgeport, the Illinois and Michigan Canal was constructed in a straight line to the Des Plaines Valley at Summit. As originally constructed, the canal had a summit level, a lock having been built at Bridgeport, and one at one-half mile south of Romeo, this summit level having been supplied originally by the Calumet Feeder.

The drainage area of the Chicago River is about 270 square miles, and the natural dry-weather flow practically nothing. The sewage of the city is discharged mainly into the river, and it early became necessary to provide some means of getting rid of it other than permitting it to escape to the lake when the flow was sufficient to carry it there. For a while pumps were operated at Bridgeport which pumped the water and sewage into the summit level of the canal. Subsequently the city deepened the canal to 6 feet below low water of 1847 in Lake Michigan, which is Chicago City datum. This gave only temporary relief. The low-water surface of the Desplaines River at Summit is 8 feet above Chicago datum, and high water rises 7 feet higher. The canal does not enter the bed of the river, except at one place where the river was diverted for the purpose, but runs along the eastern bank of the river, the water of the river being prevented from coming into the canal by the spoil banks.

The material in which the canal was excavated varies from clay at Bridgeport to gravel and bowlders at Willow Springs. The surface of the ground varies from 8 to 14 feet above Chicago datum. In many places under the head of water in the river and the drainage of the adjacent land, the narrow deep cut was unable to maintain the slope of its sides, which are said to have been cut at the slope of 1 to 1, and soon the canal became obstructed by the falling of its banks, and the flow was insufficient to carry off and properly dilute the sewage. The flow from the lake was also diminished by the water which came from the river through the permeable soil, and by the natural drainage on the east side of the canal.

Pumping works and a lock were then constructed at Bridgeport, and water pumped from the river into the canal. The lift of the lock varies from 1 to 3 feet. The capacity of these pumps is said to be 1,000 cubic feet per second and the amount pumped is from about one-half to three-fourths that quantity. This produces a feeble current up the South Branch from the North Branch and the lake when the natural flow and sewage combined does not exceed the capacity of the pumps. The South Fork, however, is left in an indescribable condition of filth and offensiveness. The West Fork originally did not extend beyond Kedzie Avenue, but by the construction of ditches and other causes it may now be said to have its source in the Des Plaines River near Summit. The upper part of its course is known as the Ogden Ditch. The ground along the West Fork is generally lower than along the canal, the low ground along part of its course being known as Mud Lake Valley. The Mud Lake Valley was originally separated from the Des Plaines River by a low bank raised probably by the river itself. This bank was cut and the city has since been engaged in an effort to prevent the water of the Des Plaines River coming down the West Fork and carrying the sewage into the lake.

A dam, known as the Ogden Dam, has been built near Summit across the Ogden Ditch where it leaves the Des Plaines River, the crest being about 11 feet above city Datum. The floods come over the dam, and over the adjacent banks and flow out to the lake through the Chicago River, carrying with them the accumulated sewage which the feeble current created by the pumps had not been able to remove. The canal drains the country south and east of it, and when the amount of storm-water is large it overtops the lock-gates at Bridgeport, which are then opened and the flood flows out to the lake through the river. The city of Chicago takes its water supply from Lake Michigan near the mouth of the Chicago River, and the purity of the water supply is threatened by the sewage carried into the lake. The city is now proposing to dig a large drainage channel along the Chicago route for the purpose of carrying its sewage down the Des Plaines and Illinois rivers.

The proposed water-way between Bridgeport and Summit could follow the line of the present canal, the West Fork and Ogden Ditch, or a line intermediate between the two, but it is necessary to take into account the local conditions and to provide for preventing the waters of Des Plaines River going to Lake Michigan, through the Chicago or Calumet rivers, carrying with them the sewage of the city of Chicago.

From Summit to Sag Bridge the proposed route follows the valley of the Des Plaines River, which is from one-half to three-fourths mile wide, entering the bed of the river about 3 miles below Summit. The river from Summit to below Sag Bridge varies greatly in width and depth. This portion of the river is known as the 12-Mile Level. The low-water flow of the river above Summit is very small, and the maximum measured high-water discharge about 10,000 cubic feet per second. At low water the entire flow passes in part through the Ogden Dam, but the greater portion into the canal through the permeable soil separating them.

SAG ROUTE.*

This route leaves Lake Michigan by the Grand Calumet River, which it follows about 3¼ miles. This river is a navigable water-way of the United States, and the General Government is at present time excavating this channel 200 feet wide and 16 feet deep below Chicago datum. The money has been appropriated for this work, and the contract is being carried out. No cost would, therefore, be incurred by making this portion of the river a part of the proposed route. The proposed route leaves the river near the center of section 18, township 37 north, range 15 east* of the third principal meridian, and runs nearly due west a little more than 1 mile, where it enters Calumet Lake. This lake is about 3½ miles in length, north and south, and about 1½ miles wide, and is still public waters of the United States. It is at the same elevation as Lake Michigan, and averages about 5 feet deep at low water. The proposed line runs in a southwesterly direction through it, thence across a low flat prairie 1¼ miles to the Little Calumet River, which it enters in the sharp bend above Riverdale.

The Grand and Little Calumet rivers unite in section 31, township 37 north, range 15 east. Above this point the Grand Calumet is a lagoon or bayou with little current, and with banks just above the water surface. Its drainage area is very small. The Little Calumet, on the contrary, drains a much larger area with a considerable flood discharge, but its low-water flow is very small. There is no perceptible fall between Blue Island and Lake Michigan at low water.

The General Government has commenced dredging that portion of the Grand Calumet lying between the junction of the rivers and Hammond, Ind. On the supposition that the Grand Calumet would finally be deepened all the way from the lake, a line was laid out following the Little Calumet to the junction of the rivers. The accompanying profiles show this portion continuous with the portion above Riverdale. The profile of the line through Lake Calumet is shown separate and joins the other profile at 26,000 feet from the junction of rivers.

The depth of the Little Calumet up to the mouth of Stony Creek averages about 8 feet, and the width a little less than 200 feet. Below Riverdale the general elevation of the land is about 6 feet above Chicago Datum. Above Riverdale the river flows through a narrow valley from 400 to 800 feet wide, the main banks being from 15 to 20 feet high.

Near Blue Island was built the dam for raising the water to supply the Calumet feeder. The feeder was excavated across the tongue of land to Stony Creek at Blue Island and then carried by an embankment along the right bank of Stony Creek to near the center of section 27, township 37 north, range 13 east, where a dam was built across Stony Creek and the creek bed used beyond that point. Lying northwest of Blue Island is a ridge of land 7 miles long and 2 wide, known as Lane's Island. The feeder passed north of Lane's Island through low, marshy ground, the elevation of which is about 10 feet above Chicago Datum. Lying south of Lane's Island is a wide marsh about 14 feet above Chicago Datum which drains around the west end of Lane's Island and down Stony Creek. Lines were laid out both north and south of Lane's Island, and both routes found quite favorable; but the northern one is believed to be the cheaper and better route. The two lines unite near the center of south side of section 15, township 37 north, range 12 east, and from thence the line continues through a valley about one-half mile wide, to the Des Plaines River at Sag Bridge. The elevation of the valley is from 8 to 18 feet above Chicago Datum. The highest point is near the southeast corner of section 17, township 37 north, range 12 east, and this originally formed the divide between the Des Plaines and Calumet basins.

SAG BRIDGE TO LAKE JOLIET.

After the junction of the Chicago and Sag routes the line follows the bed of the Des Plaines River about 2 miles, when the up-lift of limestone is met just above Lemont. From this point to near Lockport the proposed line lies in limestone rock overlaid by a thin covering of soil, in many places the rock being entirely bare. The valley varies from one-half to 1 mile wide, and through this the river winds at lower stages in a bed from 1 to 3 feet deep. At higher stages it spreads out over the valley, which is mainly used for pasture.

From Lockport to Joliet the valley is wide and the declivity great, the total fall of the river being about 35 feet in 3½ miles. At Joliet the river is forced into a narrow channel or gorge in the limestone rocks. The present canal enters the Des Plaines River from the east, near the northern limits of Joliet in the pool formed by Dam No. 1. At this dam a lock with lift of 10 feet locks the boats down to the pool formed by

* All the lands described in this report are east of the third principal meridian, and that part of the description will be omitted hereafter.

Dam No. 2. The canal leaves the river from this pool through a guard-lock and continues in embankments along the right bank of the river. Below Dam No. 2 is a dam built for water-power known as Adams Dam. The fall over the several dams at low water is as follows: Dam No. 1, 10 feet; Dam No. 2, 8 feet; Adams Dam, 6 feet. The lengths of the dams in the order named is 250, 200, and 120 feet, respectively. Below Adams Dam the river continues 2 miles in a series of rapids to Lake Joliet, the total fall of this portion at low water being 10 feet. The total fall from Lake Michigan to Lake Joliet, both being at low water, is 76 feet.

LAKE JOLIET TO LA SALLE.

Lake Joliet is about 5 miles in length and from 400 to 800 feet wide. It is simply a gorge cut in the rock to an unknown depth, the rocky shores rising from 30 to 60 feet above the water. The depth of water varies from 8 to 16 feet, but the lake is largely filled with sewage deposit. At the lower end of Lake Joliet, Treat's Island divides the river into two channels. The beds of these channels appear to be composed of large bowlders, sand, and gravel, although rock in place may be the foundation of the island itself. Borings along the left channel show that solid rock does not rise above the bottom of the proposed water-way. A short distance below the island the river-bed is smooth rock, and limestone rock outcrops on both banks. The total fall by Treat's Island at low water is 10 feet in 1⅛ miles by the left channel.

From Treat's Island to the mouth of the Kankakee River the Des Plaines flows between high, fixed banks, the low-water width being from 300 to 600 feet. At the mouth of Du Page River is a fall of about 3 feet in a distance of about 1 mile. The bed of the river is either rock or a thin layer of bowlders and gravel overlaying rock. This portion of the river is subject to backwater from the Kankakee, the highest waters being due to that cause. There is very little land subject to overflow along this portion of the route.

The Illinois River is formed by the union of the Des Plaines and Kankakee rivers, the latter contributing much the greater volume of water. Commencing in the Des Plaines 1 mile above the junction, and extending 1 mile below, are rapids, the total fall being 8 feet at low water. The river-bed in these rapids is limestone rock. Below these rapids the bed of the Illinois changes to sand and gravel, the banks become low, and the bottom lands greater in extent. The oscillation in stage is great, being about 25 feet as far down as Morris, and diminishing to 8 feet on the crest of the Marseilles Dam. The low-water discharge does not much exceed 1,000 cubic feet per second, including amount pumped at Bridgeport, while the high-water discharge is about 70,000 cubic feet per second. The river-bed continues to be sand and gravel, down to a depth of 14 feet below low water, to within about 4½ miles of the Marseilles Dam, where it changes to rock. The banks are about 15 feet above low water, and bordered by fertile farming lands, which at high water are overflowed. The width at high water in the vicinity of Morris exceeds 1 mile. High waters mainly occur in winter when little damage is done, but some of the greatest floods have occurred in summer. The low-water slope from the foot of the rapids at junction of rivers to lower end of Sugar Island, 3½ miles below Morris, is 0.35 feet per mile, a total fall of 4 feet in 11½ miles. From Sugar Island to Marseilles Dam the total fall at low water is 1 foot in 12.7 miles.

At Marseilles are rapids with a fall of about 10 feet per mile. On these rapids has been built a dam 920 feet long for water-power purposes. From Marseilles to a short distance above Utica, a distance of about 20 miles, the bed of the river is rock, and the slope great. The total fall from pool above Marseilles Dam to low water at Utica is about 40 feet. The river is divided into two or more channels by numerous islands, which are mainly cultivated, and are overflowed at high water. The valley is bounded by high hills which, in places, become nearly vertical walls of rock, the bottom-lands varying from a very narrow strip to 1 mile in width, mainly overflowed by great floods.

Near Utica the bed of the river changes to clay, sand, and mud, and continues of that character to La Salle. The valley in this portion averages a little more than 1 mile in width, is mainly cultivated, and subject to overflow at high water. Backwater from the dam at Henry extends, at low water, to Utica.

SURVEYS.

In 1883, a survey was made of the Des Plaines and Illinois Rivers from dam No. 1, at Joliet to La Salle, under the direction of Maj. W. H. H. Benyaurd, by Mr. G. Y. Wisner, assistant engineer. A party to survey the various routes between Joliet and Lake Michigan was organized and took the field October 1, 1888, under my immediate supervision. The entire width of the valleys was covered with stadia elevations and all principal objects located. The heights of the instrument stations were determined by ordinary levels, and for this purpose a continuous line of levels was carried

up each side of the valley, the two lines checking each other at frequest intervals. Elevations started from a bench-mark established on the lock-wall at Dam No. 1 by Assistant Wisner, the elevation of which is 113.755 feet above Hennepin datum, the datum used in that survey. All elevations in the present survey have been referred to the same datum. Upon reaching Chicago with the levels and connecting with city bench-marks, Chicago datum was found to be 151.5 feet above Hennepin datum. This value differs .8 foot from previous ones, and the entire distance was releveled in hopes of finding the cause of this discrepancy, but no appreciable error was found. The previous value of the relation of the two datums was 152.3 feet.

The surveys were completed to Bridgeport November 30, and the party disbanded with the exception of a small party which sounded Chicago River in the early part of December. The reduction and plotting of field-notes was at once commenced. It was found that sufficient information had not been obtained in that portion between Lockport and Dam No. 1. It was also found that the maps of the survey of 1883 did not give sufficient details between Dam No. 1 and Lake Joliet, and in the vicinities of Treat's Island and Marseilles. The maps were also found to be deficient in respect to heights of floods, the areas subject to overflow, and material composing banks and bed. A small party was organized in the spring of 1889 and made surveys of the above localities.

The results of the surveys have been plotted on eight maps with a scale of 1 inch = 400 feet, and four maps with a scale of 1 inch = 200 feet. Map of Chicago River and maps of vicinities of Joliet, Treat's Island and Marseilles are the ones that have been plotted on the larger scale.

On these maps all ground elevations have been preserved and stamped on them, using for this purpose ordinary type and the apparatus described in the Report of the Chief of Engineers for 1885. Contour lines have been drawn on the maps 1 foot apart, except on very steep slopes, where they have been drawn 5 feet apart. No topographical signs have been put on the maps, but the character of the surface, cultivated, meadow, timber, etc., has been stamped on them. The proposed routes have been laid down and the profiles of the centre lines drawn. The surface width of the water-way and the material to be excavated as determined by borings have also been shown.

BORINGS.

It was recognized from the first that in a proposed work which involved the excavation of so great an amount of material that it was of the utmost importance to determine the character of this material. Between Lemont and Joliet the character of the material could be determined quite easily. The quarries in the hill-sides the river-bed, the spoil banks of the present canal all tell the story. The rock is a stratified limestone, and in the valley contains large quantities of flinty nodules or chert. The stone suitable for quarrying lies in a thin stratum in the hill-sides. In some quarries as much as 50 feet of earth is being removed to obtain the valuable stone underneath. Near Lemont, however, and down the slope toward Joliet some valuable stone is found in the valley itself. Between Willow Springs and Sag Bridge large quantities of rock were excavated in the present canal, and between Sag Bridge and Lemont the excavated material is almost entirely rock. No rock was met on the present canal above Willow Springs. At Sag Bridge on the Sag route is an abandoned quarry, and another 1 mile east of that point. Three miles east of Sag Bridge the Calumet feeder was excavated in rock.

The drainage and water-supply commission of the city of Chicago, composed of Mr. Rudolph Hering, Mr. Benezette Williams, and Mr. S. G. Artingstall, in 18 5 caused borings to be made along the Chicago route from Bridgeport to Lemont. The results of their borings showed rock to be continuous from Summit to Lemont. A copy of their profile accompanies this report.

In 1867 the Calumet feeder was sounded with iron rods by Mr. James Worrall, who reported that the "necessity for rock excavation developed by these soundings to an extent sufficient to preclude the selection of that route for the enlarged canal." A copy of his profile accompanies this report.

An examination of these profiles led to the belief that they were both unreliable as far as indicating the position of the rock was concerned. While the field work was in progress experiments were made with steel rods to determine, if it were possible, to locate the rock by that means. But few experiments were necessary to prove that such tools were insufficient to penetrate the material overlying the rock, and to correctly indicate when rock was met. It was finally decided to solicit bids from well-borers for doing this work by contract. The contract was awarded to Josiah Stevens & Co., of Elgin, Ill., the lowest responsible bidders. Work under this contract was commenced at mouth of Stony Creek December 19, 1888, and prosecuted with great energy and perseverance, and sometimes under the most discouraging circumstances, to completion at Lemont August 2, 1889. Work was commenced with two sets of hand-tools, which proved very efficient in fine material, but made slow progress in

the bowlders and coarse gravel near east end of Lane's Island. A steam outfit was finally put on the work and more satisfactory progress made until the spring rains rendered the low marshy country well-nigh impassable to the heavy machinery. The use of the hand-tools was also continued. A fortunate spell of cold weather, when the ground was bare of snow, enabled the work to be carried over the soft, miry marsh south of Lane's Island.

Rock was met near the east end of Lane's Island on both lines, and efforts were made to find a line that would avoid it, but were not successful. The amount of rock along the feeder is small. West of the west end of Lane's Island rock was again met along the feeder. The feeder here was dug near the south side of the valley on the line of lowest surface elevations. By throwing the line close to the hills on the north side of the valley the rock was avoided until section 18, Palos township, was reached. West of that point no way to avoid the rock was found.

When the borings along the Sag route had been completed the outfits were moved to Summit, and work on the Chicago route commenced April 5, 1889. The two sets of hand-tools soon completed the borings to Bridgeport, but the steam outfit met difficult material to penetrate a short distance south of Summit. Granite and limestone bowlders, mixed with gravel and quicksand, made progress to Willow Springs very slow. The river had risen to a high stage in May and June, but the spoil banks along the canal had offered a good base of operations as far as Willow Springs. Below that point it was desirable to put the borings either in or along the river channel. The water then covered the valley, which is here partly timbered, from 1 to 3 feet deep, and prevented the further use of the steam outfit. Two small flat-boats, 8 by 16 feet, with decks 16 inches above the bottom, were then built, and the hand-tools mounted on them. In the center of the boats was a well, formed by a 4½-inch pipe, through which the tools were worked. At each corner was a stout spud for keeping the boat steady. This manner of working proved very satisfactory, but it was impossible to put any borings outside of the channel itself. Under more favorable conditions, as when the ground and river is hard frozen, a route might possibly be found which would avoid the rock met above Sag Bridge.

As this work was considered of great importance the most rigid inspection was maintained. The borings were spaced one-half mile apart along the proposed lines, and were located by reference to the stations of the survey and to the land survey lines. The elevation of the ground was determined by reference to the nearest bench-mark. Many additional borings were put down to find more favorable routes where rock was met. Some borings were abandoned by the contractors, usually from loss of tools. In such cases a second boring was put down a short distance away, but the records of the abandoned borings have been preserved. On the north side of Lane's Island four spaces, 1 mile each, were left between borings on account of the difficulty of transporting the machinery, the ground being soft and miry from spring rains and frost, but as no rock was met in that vicinity, it is considered that the nature of the material has been sufficiently well determined.

Full records were kept of daily progress, of difficulties met, and of kind and amount of material penetrated. The borings have been plotted on the maps, and sections of them shown on the profiles. Their approximate locations and depths were shown on the condensed profiles accompanying this report.

A subsequent contract was made with the same firm for putting down borings in the Illinois River between the Kankakee River and Marseilles. Work under this contract was commenced August 7 and completed August 22, 1889. The hand tools and flat-boats were used, and rapid progress made. The borings and sections have been plotted on the maps of that portion of the river.

A party was also put in the field for making special examinations with regard to location of rock in and around Joliet, at Treat's Island, at mouth of Du Page River, at Kankakee feeder aqueduct, and in the river from Marseilles to La Salle. This party also determined elevation of high-water marks, and obtained other miscellaneous information. They were not provided with a complete boring outfit, but it is believed that the information obtained is reliable.

Accompanying this report are reports of all borings made; details as to daily progress, difficulties, etc., being omitted. Enough information is given in each case to enable the borings to be plotted on any sectional map, and to give a fair idea of the mat rial met. The time occupied in making a boring will give some idea of the difficulties encountered.

DIMENSIONS OF PROPOSED WATER-WAY.

As the act of Congress does not state whether 160 feet is the surface or bottom width it has been taken as the width at 7 feet above the bottom in that portion of the route north of Joliet. The side slopes in earth have been taken one and one-half horizontal to one vertical, making bottom width 139 feet. In rock the sides

have been made vertical. It is not believed, however, that the material in some portions of the lines would preserve these slopes. The lines south of Lane's Island through the large marsh would present considerable difficulties in the way of excavating and maintaining a water-way of the proposed dimensions. This is one of the reasons for preferring the route north of Lane's Island. In the Chicago route there is considerable quicksand and fine gravel which will not stand under these slopes. An estimate has been made for docking the sides for 42,000 feet of this route.

After the proposed water-way passes into the Des Plaines and Illinois Rivers the width has been made the minimum that it was thought a boat 75 feet wide could follow in an open river. In the excavation by the rapids at Treat's Island the width at bottom is 160 feet, and side slopes 2 to 1. The channel would be quite well defined. In all the rock excavation in the rivers the width has been made 200 feet, with sides vertical. In the sections in soft earth the bottom width has been taken as 160 feet, with side slopes 5 to 1. It is very probable that the required depths would not be maintained even under these gentle slopes, and that large annual expenditures would be required to dredge out material filled in by floods. In the rock excavation for the canal by the rapids at Marseilles the width has been taken 160 feet with sides vertical.

Estimates have been made for two projects, one giving a depth of 14 feet, the other a depth of 8 feet, the bottom width and slope of sides being the same. No allowance has been made for longitudinal slope. Cross-sections of the proposed water-way on which the estimated amount of excavation is based, are shown on the plates accompanying this report.

The project for reaching La Salle from Lake Michigan with the proposed water-way includes the excavation of a level cut through the divide from Lake Michigan; the construction of a guard-lock to prevent the flood waters of the Des Plaines River from going to Lake Michigan; the construction of suitable gates and weir above Lockport to regulate the amount of water flowing in the canal; the construction of retaining walls, locks, and dams to carry the canal down the slope past Joliet to Lake Joliet; and, the improvement of the Des Plaines and Illinois rivers by means of locks and dams and by excavation.

EXCAVATION.

Chicago route.—It is estimated from the soundings taken in the Chicago River in December, 1888, that 173,000 cubic yards of dredging would be necessary to deepen the present channel to 14 feet. To increase the width to 160 feet it is estimated that 240,000 cubic yards of excavation would be necessary. Both these items would probably be necessary under the 8-foot project. Increasing the width of the river would necessarily be expensive, as it would be necessary to remove the present docks and to rebuild 11,500 feet of new docks. The proposed dock lines have been laid out so as to take the minimum amount of land and to avoid as far as possible the valuable structures. The channel, as laid out, is necessarily crooked, with many sharp bends. The amount of land necessary to be taken is estimated at 325,000 square feet, and more would be necessary if a channel with moderate curves was to be laid out. The estimated price for widening and deepening the Chicago River is based upon the cost of dredging done by the city, and includes cost of removal of present docks where width is increased.

Between Bridgeport and Summit two lines have been estimated on, one leaving the West Fork just west of Ashland avenue and running parallel to and about 1,200 feet from the present canal, the other following the West Fork and Ogden Ditch and joining the first at Summit. If the line of the present canal was followed the amount of excavation would practically be the same as the first line. The possible advantage in following the canal would lie in the value of the 240-foot strip of land occupied, which would probably be offset by the fact that the canal is paralleled here on either side by a railroad, and that sufficient width for right-of-way can not be obtained between them. The estimated amounts of excavation for the first line is, for 14-foot project, 6,892,000 cubic yards, and for 8-foot project, 4,990,000 cubic yards. For the second line the same amounts are 5,191,000 and 3,411,000 cubic yards respectively. The line following the West Fork and Ogden Ditch is therefore believed to be the more favorable one and will be used in estimating cost of Chicago route.

An estimate has been made on all the proposed lines of the amount of heavy bowlders and other material which it is believed will present greater difficulties in excavation than ordinary earth and material termed hard pan. The amount of hard pan is purely a matter of estimation based upon the information gained from the borings and upon personal knowledge of the vicinities. The cost of excavating this hard pan will vary from the cost of earth to that of rock excavation. The total amounts of

excavation in Chicago route to junction of routes at Sag Bridge are given in the following table:

Material.	Price per yard.	14-foot project.		8-foot project.	
		Cubic yds.	Cost.	Cubic yds.	Cost.
Earth	$0.40	413,000	$165,200	413,000	$165,200
Earth	.25	9,989,000	2,497,250	6,730,000	1,682,500
Hardpan	.60	1,360,000	816,000	920,000	552,000
Rock	1.60	497,800	796,480	251,000	401,600
Total			4,274,930		2,801,300

To the above cost of excavation is to be added the cost of rebuilding 11,500 feet of dock along Chicago River, which is estimated to cost, at $15 per foot, $172,500. It is also estimated that 42,000 feet of the proposed channel would require to be docked on both sides to maintain the depth. This is estimated to cost $10 per foot for 14-foot project, and $8 for 8-foot project. This makes the total cost to Sag Bridge for excavation for the two projects, $5,286,430 and $3,645,800, respectively.

Sag route.—The amount of material to be excavated between Grand Calumet River and Little Calumet River, on the line through Lake Calumet, is 2,065,000 cubic yards earth for 14-foot project, and 1,155,000 cubic yards for 8-foot project. The amounts of excavation for the same projects following the Little Calumet River to the same point, 26,000 feet from junction of rivers, are 953,000 and 115,000 cubic yards respectively. The first of these lines is preferred, because the distance to Lake Michigan is about five miles less than by the second, and also because Lake Calumet offers a site for a harbor of the largest proportions. Under present conditions, it would be necessary to add to the amounts for the second line the amounts necessary to enlarge the Grand Calumet River between the points where the two lines enter it.

In that portion of the Sag route which offers a choice of passing north or south of Lane's Island, the amounts of excavation are as shown in the following table:

Material.	North of Lane's Island.		South of Lane's Island.	
	14-foot project.	8-foot project.	14-foot project.	8-foot project.
	Cu. yards.	*Cu. yards.*	*Cu. yards.*	*Cu. yards.*
Earth	7,246,000	5,147,000	6,931,000	5,318,000
Hardpan	768,000	539,000	317,000	232,000
Rock	186,500	7,300	1,094,300	589,025

The line north of Lane's Island will be followed in the estimates for the Sag route.

The total amounts of excavation between Grand Calumet River and junction of routes at Sag Bridge are given in the following table:

Material.	Price per yard.	14-foot project.		8-foot project.	
		Cubic yards.	Cost.	Cubic yards.	Cost.
Earth	$0.25	13 814,000	$3,453,500	9,562,000	$2,390,500
Hardpan	.60	944,000	566,400	703,000	421,800
Rock	1.60	1,264,700	2,023,520	536,800	858,880
Total			6,043,420		3,671,180

Sag Bridge to Lake Joliet.—For a short distance below junction of routes at Sag Bridge the material is part earth and part rock. After the proposed route meets the rock up-lift above Lemont the line continues in solid rock cutting to the proposed waste-gates at Lockport. From the waste-gates to the first lock below Joliet the proposed bottom lines are common to the two projects. In the basin between the two dams at Joliet it is proposeed to excavate the gravel and sewage deposit down

to the original bottom of the present canal. Is is proposed to widen the present canal below Joliet to 160 feet down to the first proposed lift-lock, the material to be excavated being all rock. The lift of this lock has been placed at 8 feet for the 14-foot project. This would make the lower level coincide with that of the present canal, which would then be intact from Joliet to La Salle, and could be maintained if desired. In the 8-foot project the lift has been placed at 11 feet, and the canals would separate above the lock. It would be necessary to raise the embankment of the present canal 2 feet throughout the Channahon level if its use were to be continued.

It is proposed to raise the water surface in Lake Joliet to an elevation of 80 feet, or about 5 feet above low water, by means of a dam at lower end of Treat's Island, and to pass from the canal into Lake Joliet with the 14-foot project by means of a combined lock, the lift of which would be 20 feet. In the 8-foot project Lake Joliet would be entered by means of a single lock with a lift of 11 feet. The material to be excavated between Lock No. 5 and the combined lock consists of gravel and bowlders of all sizes compacted together. Below the combined lock the same material continues for about 1,000 feet, where the material changes to sand and mud. The following table contains the various items for excavating this portion of the proposed water-way, the numbering of the locks in the table being that of the 14-foot project:

Item.	Material.	Price per cubic yard.	14-foot project.		8 foot project.	
			Cubic yards.	Cost.	Cubic yards.	Cost.
Sag Bridge to waste-gates	Earth	$0.25	672,000	$168,000	561,000	$140,250
	Rock	1.60	4,598,800	7,358,080	2,812,700	4,500,320
Waste-gates to Lock No. 1	....do	.80	126,100	100,880	109,300	87,440
Lock No. 1 to Lock No. 2	....do	.80	19,600	15,680	19,600	15,680
Lock No. 2 to Lock No. 3	....do	.80	34,100	27,280	34,100	27,280
Lock No. 3 to Lock No. 4	.. do	.80	104,000	83,200	104,000	83,200
In basin at Joliet	Earth	.25	24,000	6,000	24,000	6,000
Lock No. 4 to Lock No. 5	Rock	1.00	236,000	236,000	236,000	236,000
Lock No. 5 to Lock No. 6	Hardpan	.60	53,000	31,800	106,000	63,600
Below Lock No. 7	....do	.60	51,000	31,600	25,000	15,000
	Earth	.25	145,000	36,250	.....	.....
Total	.....	.....	.....	8,093,770	.....	5,174,770

Lake Joliet to La Salle.—In this portion of the proposed water-way the required depths have been obtained as far as possible by raising the water surfaces by means of dams. The water surfaces have been made the same for the two projects and placed as high as the topography would permit. The proposed sites of dams are at lower end of Treat's Island, 1 mile above Kankakee River, 1 mile below mouth of same river, at lower end of Sugar Island, at Marseilles, at head of island above Ottawa, at Lover's Leap, and at Utica. The rapids at Marseilles it is proposed to pass by means of a canal and three locks. Where the dams do not give the required depth it is proposed to obtain it by excavation. The following table contains the various items for excavating this portion of the proposed water-way:

Item.	Material.	Price per cubic yard.	14-foot project.		8-foot project.	
			Cubic yards.	Cost.	Cubic yards.	Cost.
Above Lock No. 8	Hard pan	$1.00	154,000	$154,000	4,000	$4,000
Lock No. 8 to Lock No. 9	....do	1.00	33,000	33,000	24,000	24,000
	Rock	3.00	372,800	1,118,400	12,000	36,000
Lock No. 9 to Lock No. 10	....do	3.00	478,800	1,436,400	138,800	416,400
Lock No. 10 to Lock No. 11	Earth	.25	3,555,000	888,750	781,000	195,250
Lock No. 11 to guard-Lock	.. do	.25	1,494,000	373,500	176,000	44,000
	Rock	3.00	839,800	2,519,400	133,000	399,000
Guard-Lock to Lock No. 12	Earth	.30	55,000	16,500	55,000	16,500
	Rock	3.00	111,000	333,000	32,500	97,500
Lock No. 12 to Lock No. 13	....do	3.00	94,300	282,900	18,100	54,300
Lock No. 13 to Lock No. 14	...do	3.00	582,100	1,746,300	68,300	204,900
Lock No. 14 to Lock No. 15	....do	3.00	1,579,800	4,739,400	101,400	304,200
Lock No. 15 to Lock No. 16	....do	3.00	207,800	623,400	32,500	97,500
Below Lock No. 16	Earth	.25	2,023,000	505,750	503,000	125,750
Total	.....	.....	.....	14,770,700	.....	2,049,300

The total amounts for excavation between Lake Michigan and La Salle, not including excavation for locks, are as follows:

	14-foot project.	8-foot project.
By Chicago route	$28,151,900	$10,839,870
By Sag route	28,907,890	10,865,250

RETAINING-WALLS AND EMBANKMENTS.

As the proposed water-way passes out of the limestone excavation near Lockport it is carried along the west side of the valley in embankment, the aim being to keep the bottom near the surface of the ground in order to avoid as much as possible rock excavation. It is proposed to make this embankment by means of a rubble masonry wall backed by waste stone. For both projects this retaining-wall has a top width of 5 feet, back vertical, and batter of face 0.2 foot per foot. Above the first lock in the 14-foot project the top has been placed at 5 feet above low-water of Lake Michigan, but in all other cases for both projects it is placed at 2 feet above proposed water surfaces. The backing is estimated with top width one-half the height and sloping 1.2 to 1. As proportioned the wall for 8-foot project would not need the backing to withstand the water pressure alone. At each of the first three locks of the 14-foot project and corresponding locks of 8-foot project, a short dam or retaining-wall is necessary to connect the lock with the hills at the west side of the valley. The cross-section of these dams is of the same form as of the retaining-walls between the locks which are shown on the accompanying plates. The quantities and estimated cost are given in the following table:

Item.	Length.	Material.	Price per cubic yard.	14-foot project.		8-foot project.	
				Cubic yards.	Cost.	Cubic yards.	Cost.
	Feet.						
Waste-gates to Lock No. 1	12,200	Masonry	$5.00	68,900	$344,500	33,900	$169,500
		Backing	.20	162,000	32,400	43,000	8,600
Lock No. 1 to Lock No. 2	8,300	Masonry	5.00	41,400	207,000	26,500	132,500
		Backing	.20	95,000	19,000	43,000	8,600
Lock No. 2 to Lock No. 3	1,800	Masonry	5.00	6,500	32,500	3,700	18,500
		Backing	.20	12,000	2,400	4,000	800
Lock No. 3 to Lock No. 4	2,500	Masonry	5.00	15,500	77,500	8,700	43,500
		Backing	.20	12,000	2,400	4,000	800
Total					717,700		382,800

An alternate project for constructing these embankments is to make them of earth brought from the hills on the west side of the valley. The embankments have been computed as 12 feet wide on top with sides sloping $1\frac{1}{2}$ to 1, the water slope to be covered with riprap 2 feet thick. The quantities and estimated cost are given in the following table:

Material.	Price per cubic yard.	14-foot project.		8-foot project.	
		Cu. yards.	Cost.	Cu. yards.	Cost.
Earth	$0.50	623,500	$311,750	256,600	$128,300
Riprap	.20	58,400	11,680	22,700	4,540
Total			323,430		132,840

This method of constructing these embankments is not recommended especially for the 14-foot project above Lock No. 1, as the embankment there would be all that prevented the water of Lake Michigan from passing down the valley. The sudden failure of any of these embankments would probably entail loss of life in the valley below.

The project for passing Joliet includes the removal of the two State dams and the construction of a movable dam near the site of the lower one.

This movable dam is made necessary by the fact that the proposed water-way will bring down to Joliet flood waters which before passed to Lake Michigan.

Under the 14-foot project the water surface is to be raised 8 feet, making it several feet above the land surface along the east side of the river. A retaining wall is therefore necessary on that side from the present embankment above the upper dam to the proposed dam. The present embankment above upper dam is 5 feet above low-water surface and as removing that dam will lower the water surface 2 feet it is not considered necessary to strengthen this embankment. Back of the proposed retaining-wall a conduit would be necessary to conduct the drainage of that portion of the city below the proposed dam. The conduit would pass under two streets and would be arched under them. Otherwise the retaining-wall and conduit would be as shown on the accompanying plate.

Under the 8-foot project the water surface above lower dam would be raised 2 feet and above upper dam would be lowered 8 feet. It would be necessary to construct a retaining-wall between the two dams, but the conduit would not be necessary. The following table gives the items and estimated cost of the retaining-walls and conduit:

Item.	Price.	14-foot project.				8-foot project, retaining-wall.	
		Retaining-wall.		Conduit.			
		Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Excavation, rock	$1.00	2,000	$2,000	.....	.....	1,300	$1,300
Excavation, earth	.30	19,000	5,700	20,500	$6,150	15,000	4,500
Masonry	5.00	16,500	82,500	6,350	31,750	9,200	46,000
Grading	.30	32,500	9,750	9,000	2,700	15,000	4,500
Total		.....	99,950	.....	40,600	.....	56,300

Below Dam No. 2 the present canal is carried along the west side of the river by an earthen embankment. The canal section has been excavated in rock and the rock wasted between the embankment and river and in the river itself. The embankment has a dry wall on the canal side, and where the room is limited, on the back also, but it is mainly backed by waste stone. Above the proposed guard-lock it is proposed to raise this embankment by means of a rubble-masonry wall with top 5 feet above proposed water surfaces. Below the guard-lock the rubble-masonry wall is to be continued to Lock No. 5 with top 2 feet above water surface for 14-foot project. Under the 8-foot project, however, for this portion it is proposed to raise the present earthen embankment 2 feet. Below Lock No. 5 the embankments for both projects are to be constructed of earth, with water slope covered with riprap.

The following table gives the items and estimated cost of the retaining-walls between the proposed dam at Joliet and Lake Joliet:

Item.	Material.	Price per cubic yard.	14-foot project.		8-foot project.	
			Cubic yards.	Cost.	Cubic yards.	Cost.
Above guard-lock	Masonry	$5.00	4,300	$21,500	2,700	$13,500
	Backing	.20	5,500	1,100	1,900	380
Guard-lock to Lock No. 5	Masonry	5.00	19,400	97,000	.....	.....
	Backing	.20	19,500	3,900	.....	.....
	Dry wall	2.00	.....	.....	700	1,400
	Earth	.50	.....	.....	5,000	2,500
Lock No. 5 to Lock No. 6	Riprap	.40	10,000	4,000	4,600	1,840
	Earth	.40	108,600	43,440	31,600	12,640
Total	.....	.....	.....	170,940	.....	32,260

The embankments of the canal by the rapids at Marseilles it is proposed to construct of earth, the inner slope to be covered with riprap and the outer slope to be covered with riprap and paved. The embankments are to be raised 2 feet above high water for both projects, and it is estimated that 40 cents per yard will cover their cost, including riprap and paving. The following table gives the items and

amounts for these embankments. Cross-sections are given on the accompanying plates.

Item.	Length.	Price per cubic yard.	14-foot project.		8-foot project.	
			Cubic yards.	Cost.	Cubic yards.	Cost.
	Feet.					
Above guard-lock	240	$0.40	6,700	$2,680	6,700	$2,680
Guard-lock	600	.40	41,300	16,520	41,300	16,520
Guard-lock to Lock No. 12	2,230	.40	46,400	18,560	46,400	18,560
Lock No. 12	600	.40	34,800	13,920	34,800	13,920
Lock No. 12 to Lock No. 13	2,630	.40	79,000	31,600	79,000	31,600
Lock No. 13	600	.40	29,400	11,760	29,400	11,760
Total				95,040		95,040

The following is a summary of the total cost of retaining walls and embankments between Lake Michigan and La Salle:

Item.	14-foot project.	8-foot project.
Above Joliet	$717,700	$382,800
At Joliet	140,550	56,300
Joliet to Lake Joliet	170,940	32,260
At Marseilles	95,040	95,040
Total	1,124,230	566,400

BRIDGES.

In making the estimates of the cost of bridges, the cost of bridges actually constructed in Chicago have been mainly relied upon for cost of city bridges. I am also indebted to Mr. A. Gottleib, consulting engineer, Edge Moor Bridge Works, for valuable information concerning cost of superstructure of swing-bridges. Over the Chicago River are many fine bridges which lack the necessary clear opening to pass vessels of the width for which the locks are designed. In such cases new bridges have been estimated for, although part of this cost might be saved even if new bridges were to be constructed. This would be more than counterbalanced, however, by the land damages for bridges above Van Buren street, for which no estimate has been included.

In all, seventy-two bridges have been estimated for between Lake Michigan and Lake Joliet. If the Chicago route is followed, forty-five bridges are necessary, and if the Sag route is followed, thirty-eight are necessary. Between Lake Joliet and La Salle, twelve bridges are necessary. The bridges have been divided into five classes and an average cost for each class estimated.

Class 1 includes double track, heavy traffic railroad bridges with steam power; estimated cost, $85,000. Class 2 includes single track, heavy traffic railroad bridges with hand power; estimated cost, $50,000. Class 3 includes double roadway, heavy traffic street bridges with steam power; estimated cost, $135,000. Class 4 includes single roadway, heavy traffic street bridges with steam power; estimated cost, $60,000. Class 5 includes single track, country road bridges with hand power; estimated cost, $15,000.

The following table shows the estimated cost of bridges on the several sections of the proposed routes. The total cost for bridges to La Salle is, following Chicago route, $3,660,000, and following Sag route, $1,850,000:

Class.	Price.	Chicago route.		Sag route.		Sag Bridge to Lake Joliet.		Lake Joliet to La Salle.	
		No.	Cost.	No.	Cost.	No.	Cost.	No.	Cost.
1	$85,000	6	$510,000	5	$425,000	1	$85,000	.....	.....
2	50,000	3	150,000	6	300,000	2	100,000	5	$250,000
3	135,000	13	1,755,000	.....	.....	.....	.....	.....	.....
4	60,000	6	360,000	2	120,000	3	180,000	.....	.....
5	15,000	6	90,000	14	210,000	5	75,000	7	105,000
Total		34	2,865,000	27	1,055,000	11	440,000	12	355,000

RIGHT OF WAY AND LAND DAMAGES.

In estimating the cost of right of way through Chicago the minimum amount of land necessary to obtain 160 feet in width has been taken. Throughout all the proposed routes in excavation a width of 600 feet has been considered necessary. Where the canal passes into embankment near Lockport the total amount of land overflowed has been included. In passing through Joliet the land necessary to the project here outlined has been taken, but the most economical project for passing Joliet with a wide canal can not definitely be known until condemnation proceedings shall have settled the question of cost of right of way. Along the Des Plaines and Illinois Rivers the lands permanently overflowed by the proposed water surfaces have been included. No attempt has been made to estimate land damages in the city of Chicago caused by reconstruction of bridges, or to estimate damages due to increased height of floods along the Illinois River.

A real-estate firm was employed to appraise values in and around Chicago. For country lands and property at Joliet, the assessed values in 1888 were obtained from the county records, and a ratio of those values to present values assumed. This ratio for country property was taken as four and for Joliet property as five. Lands along the Des Plaines and Illinois rivers were valued at $70 per acre. The several items of estimated cost for right of way are as follows:

Chicago route	$1,197,250
Sag route	272,150
Sag Bridge to Joliet	75,070
At Joliet	227,260
Des Plaines and Illinois valleys	138,040
Total following Chicago route	1,637,620
Total following Sag route	712,520

LOCKS.

The locks have been designed with chamber 75 by 350 feet, similar to those in process of construction on the Lower Illinois River, but with much lighter walls. River walls have been estimated with coping 6 feet wide and base equal to 0.5 (height —2 feet). Land walls have been estimated with coping 5 feet wide and base $= 0.45\,(h - 2)$. For a length of 118 feet adjoining the gates the coping has been made 13 feet wide, except opposite the gate recesses and base $= 0.45\,(h - 2) + 8$ for land walls and $0.5\,(h - 2)$ for river walls. Walls have been carried 2 feet above high water except locks 11, 13, and 16, which would be submerged at high water. Concrete has been estimated $3\frac{1}{2}$ feet thick under walls and chambers, and $5\frac{1}{2}$ feet thick under miter-sills. Prices of material, gates, maneuvering machinery, etc., have been taken from cost of similar locks already constructed. Tables of detailed estimates of cost of locks accompany this report.

DAMS.

Included in the cost of dams is the cost of the sluice-ways and weir at Lockport. The sluice-ways, eight in number, are each 25 by 12 feet, with top 5 feet above low water in Lake Michigan. The weir has been made 300 feet long, with crest 2 feet above same level.

The cost of the sluice-ways has been taken from the cost of similar sluice-ways built on the Fox River.

The proposed dam at Joliet has a movable section, 75 by 10 feet for 14-foot project and 100 by 7 feet for 8-foot project. The dams at Sugar Island and Utica would both be backed out and are each estimated with a navigable pass 300 feet wide, closed by Chanoine wickets. The cost of the navigable passes has been taken from the cost of similarstructures on the Kanawha River. Otherwise than the movable portions, the dams have been designed to be built of timber crib-work filled with stone. Tables of detailed estimates of cost of dams accompany this report.

The effect of the proposed dams on flood heights and slopes of the Illinois River may be approximately determined in the following manner: The proposed dams, except that at Marseilles, will be submerged at high water. Several formulae have been proposed for estimating the discharge over submerged weirs, but the one entitled to the most confidence is probably that proposed by Clemens Herschel, which is as follows:

$$Q = 3.33\, l\,(n\,H)^{\frac{3}{2}}$$

in which Q = discharge in cubic feet per second,

l = length of weir,

H = height above crest of water above dam,

H' = height above crest of water below dam,

and, n = a co-efficient depending on $\frac{H'}{H}$.

The value of n for values of $\frac{H'}{H}$ varying from 0 to 1 have been deduced by Herschel from experiments, and are given in the Transactions American Society of Civil Engineers for 1885.

The discharge may be determined by applying the ordinary weir formula to the observed heights on the dam at Marseilles. Having given these values of Q and l it is desired to find H and H'. This may be done by substituting known values in the above formula and computing n from an assumed value of H. With the value of n thus found H' may be found from the table, and the fall over the dam becomes known. If we make present height of high water the limiting value of H', then we may by successive approximations arrive at the value of H.

Transposing the formula for computation, we have

$$n=\left(\frac{Q}{3.33lH^{\frac{3}{2}}}\right)^{\frac{2}{3}}.$$

The proposed dam at Utica is to consist of a fixed portion 194 feet in length with crest 18 feet below high water of 1883, and a movable section 500 feet long with crest 8 feet lower than fixed crest. Computed from height on Marseilles Dam, discharge at high water of 1883 was 63,000 cubic feet per second. If we assume 24 feet as an average distance of crests below high water and substitute these values in the formula, we find the fall over the dam less than 0.5 foot. The dam would, therefore, be practically backed out and have no effect on high-water slopes and heights.

The dam at Lover's Leap, as proposed, is 1,020 feet long, with crest fixed at 12 feet below high water. Taking the discharge as 63,000 and substituting these values in the formula, we find the fall over the dam would be 1 foot. If we accept this result, then high water above this dam would be increased 1 foot and the slope modified to that extent. The total fall from proposed dam at Ottawa to this dam is 10 feet at high water in a distance of 9.6 miles. If we suppose this fall to be decreased 1 foot, and take the formula $V=C\sqrt{rs}$ as expressing the relation of velocity and slope, the velocity at high water would be decreased only 5 per cent. in this portion of the river by the construction of the dam at Lover's Leap. The velocity can only be inferred from the slope of 1 foot per mile, which would be unequally distributed.

The dam at Ottawa as proposed is 930 feet long, with crest fixed at 10 feet below high water of 1883. Assuming the discharge as 63,000, and substituting in the formula, the fall over the dam is found to be 1.6 feet. The distance to proposed lock at foot of rapids at Marseilles is 4.5 miles and the fall at high water about 4.5 feet. The formula would indicate that the total fall would be diminished not more than 1.6 feet, which would correspond to a decrease of velocity of about 20 per cent. by the construction of the dam at Ottawa.

The dam at Marseilles would not be submerged and would increase flood heights immediately above it about 2 feet, but it is questionable if that increase would extend far up-stream under the steep slope at high water. This slope is now about 2 feet per mile for 5 miles.

The dam at Sugar Island as proposed has movable section 300 feet long, with crest 21 feet below high water of 1883, and a fixed portion 800 feet long, with crest 15 feet below same high water. In addition, the water would pass the dam on the south side in a stream one-half mile wide and from 5 to 11 feet deep. If we assume that the discharging capacity is equivalent to that of a dam 1,100 feet long, with crest 18 feet below high water, then the formula would show that the fall over the dam would be less than 0.4 feet. The dam would undoubtedly be backed out long before high-water stage was reached. The high-water slope is about 0.8 foot per mile, and would not be changed by the proposed dam.

The dam below mouth of Kankakee River it is proposed to make 640 feet long, with crest 15 feet below high water of 1887. The discharge at high water of 1887 at Marseilles was about 40,000 cubic feet per second. Substituting these values in the formula we find the fall over the dam a little less than 0.8 foot. The high-water slope in this vicinity is about 2 feet per mile, and would not be modified by the construction of the proposed dam.

It is evident that if the above results are even an approximation to the effect of the proposed improvements on the Illinois River down to La Salle, then the river would not be navigable at high water at mouth of Kankakee River for 5 miles above Marseilles and between Marsejlles and Lover's Leap, if those improvements were carried out. Whatever errors there may be in these results are probably in favor of the improvements, and actual conditions would be more unfavorable than those shown.

SUMMARY.

The following tables show the cost for both projects from Lake Michigan to Sag Bridge by both routes; also the total cost to La Salle for both projects by both routes:

SUMMARY OF COST TO SAG BRIDGE.

Items.	Chicago route.		Sag route.	
	14-foot project.	8-foot project.	14-foot project.	8-foot project.
Excavation	$5,287,430	$3,645,800	$6,043,420	$3,671,180
Guard-lock	368,130	283,819	357,649	268,309
Bridges	2,865,000	2,865,000	1,055,000	1,055,000
Right of way	1,197,250	1,197,250	272,150	272,150
Contingencies, 10 per cent	971,781	799,187	772,822	526,664
Totals	10,689,591	8,791,056	8,501,041	5,793,303

SUMMARY OF COST TO LA SALLE.

Excavation	$28,151,900	$10,839,870	$28,907,890	$10,865,250
Retaining-walls and embankments	1,124,230	566,400	1,124,230	566,400
Bridges	3,660,000	3,660,000	1,850,000	1,850,000
Right of way	1,637,620	1,637,620	712,520	712,520
Locks	8,080,650	6,530,415	8,070,169	6,514,905
Dams	1,239,021	1,204,925	1,239,021	1,204,925
Contingencies, 10 per cent	4,389,342	2,443,923	4,190,383	2,171,400
Totals	48,282,763	26,883,153	46,094,213	23,885,400

The following gentlemen have assisted in the field work and office reductions: J. H. Flagg, G. W. Sewall, Hermann Heinze, W. F. Richards, W. S. Gamble, W. G. McConnel, J. W. Woermann, and R. B. Stearns.

The locks and dams have been designed by yourself. The cost of locks and dams has been computed by J. C. des Granges and C. V. Brainard.

Very respectfully, your obedient servant,

L. L. WHEELER,
Assistant Engineer.

Detailed estimates of cost of locks for 14*-foot project.*

Item.	Unit.	Price.	Guard-lock at Summit; land-lock; height of wall, 26 feet; pile foundation.		Guard-lock at Sag Bridge; land-lock; height of walls, 23 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yard	$16.00	13,171	$210,736.00	10,876	$174,016.00
Concrete	do	6.00	6,892	41,352.00	6,674	40,044.00
Timber	M board measure	27.50	778,277	21,402.62	631,752	17,373.18
Iron	Pounds	.06	59,589	3,575.34	32,922	1,975.32
Piles	One	6.00	2,904	17,424.00		
Gates, valves, etc				26,500.00		25,500.00
Pumping and coffer-dam.				5,600.00		5,600.00
Excavation:						
Rock	Cubic yard	1.50			32,100	48,150.00
Hard pan	do	.60			58,600	35,160.00
Earth	do	.30	97,100	29,130.00		
Grading	do	.30	24,700	7,410.00	16,100	4,830.00
Keeper's house				5,000.00		5,000.00
Total				368,129.00		357,648.50

Detailed estimates of cost of locks for 14*-foot project*—Continued.

Item.	Unit.	Price.	Lock No. 1; river lock; lift, 10 feet; height of walls, 33 feet; rock foundation.		Lock No. 2; river lock; lift, 10 feet; height of walls, 28 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yard	$16.00	18,442	$295,072.00	14,299	$228,784.00
Concrete	do	6.00	7,238	43,428.00	6,949	41,694.00
Timber	M board measure.	27.50	658,873	18,119.01	643,739	17,702.82
Iron	Pounds	.06	35,385	2,123.10	32,972	1,978.32
Piles	One	6.00				
Gates, valves, etc				27,000.00		25,500.00
Pumping and coffer-dam.				5,600.00		5,600.00
Excavation:						
Rock	Cubic yard	1.50	28,300	42,450.00	24,700	37,050.00
Hard pan	do	.60				
Earth	do	.30				
Grading	do	.30	18,600	5,580.00	16,300	4,890.00
Keeper's house				5,000.00		5,000.00
Totals				444,372.11		368,199.14

Item.	Unit.	Price.	Lock No. 3; river lock; 11½ feet lift; height of walls, 30 feet; rock foundation.		Lock No. 4; at Joliet; river lock; 12 feet lift; height of walls, 30 feet; rock foundation.		Guard-lock at Joliet; land lock; height of walls, 23 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yard	$16.00	16,012	$256,192.00	16,041	$256,656.00	10,876	$174,016.00
Concrete	do	6.00	7,063	42,378.00	7,063	42,378.00	6,674	40,044.00
Timber	M board measure.	27.50	647,487	17,805.89	647,487	17,805.89	631,752	17,373.18
Iron	Pound	.06	34,178	2,050.68	34,178	2,050.68	32,922	1,975.32
Piles	One	6.00						
Gates, valves, etc				26,000.00		26,000.00		25,500.00
Pumping and coffer-dam.				5,600.00		33,600.00		5,600.00
Excavation:								
Rock	Cubic yard	1.50	19,900	29,850.00	52,000	78,000.00	26,700	40,050.00
Hard pan	do	.60						
Earth	do	.30						
Grading	do	.30	15,500	4,650.00	13,200	3,960.00	24,100	7,230.00
Keeper's house				5,000.00		5,000.00		5,000.00
Totals				389,526.57		465,450.57		316,788.50

Detailed estimates of cost of locks for 14*-foot project*—Continued.

Item.	Unit.	Price.	Lock No. 5; land lock; 8 feet lift; height of walls; 26 feet; rock foundation.		Locks Nos. 6 and 7 combined; land locks, 10 feet lift each; height of walls; 28 feet; rock foundation.		Lock No. 8, at Treat's Island; land lock; 10 feet lift; height of walls 32 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yard	$16.00	13,858	$221,728.00	25,686	$410,976.00	19,316	$309,056.00
Concrete	do	6.00	6,892	41,352.00	12,108	72,648.00	7,238	43,428.00
Timber	M board measure.	27.50	641,709	17,647.00	1,108,624	30,487.16	664,484	18,273.31
Iron	Pound	.06	32,379	1,942.74	56,010	3,360.60	35,199	2,111.94
Piles	One	6.00						
Gates, valves, etc				25,250.00		39,500.00		26,750.00
Pumping and coffer dam.				5,600.00		5,600.00		5,600.00
Excavation:								
Rock	Cubic yard	1.50	24,000	36,000.00			16,000	24,000.00
Hard pan	do	0.60			51,900	31,140.00		
Earth	do	.30					28,000	8,400.00
Grading	do	.30	31,500	9,450.00	50,700	15,210.00	23,800	7,140.00
Keeper's house				5,000.00		5,000.00		5,000.00
Totals				363,969.74		613,921.76		449,759.25

Item.	Unit.	Price.	Lock No. 11, at Sugar Island; land lock; 4 feet lift; height of walls, 30 feet; pile foundation.		Lock No. 9, above mouth of Kankakee River; land lock; 8 feet lift; height of walls, 38 feet; rock foundation.		Lock No. 10, below mouth of Kankakee River; river lock; 6 feet lift; height of walls, 39 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yards	$16.00	16,968	$271,488.00	24,801	$396,816.00	23,590	$377,536.00
Concrete	do	6.00	7,121	42,726.00	7,524	45,144.00	7,565	45,390.00
Timber	M board measure.	27.50	844,455	22,122.51	693,402	19,068.56	694,981	19,111.98
Iron	Pound	.06	65,839	3,950.34	38,037	2,282.22	38,229	2,293.74
Piles	One	6.00	3,252	19,512.00				
Gates, valves, etc				27,250.00		29,250.00		29,750.00
Pumping and coffer dam.				5,600.00		5,600.00		33,600.00
Excavation:								
Rock	Cubic yards	1.50			32,000	48,000.00	35,600	53,400.00
Hard pan	do	.60						
Earth	do	.30	59,000	17,700.00	11,000	3,300.00		
Grading	do	.30	28,800	8,640.00	28,200	8,460.00	11,700	3,510.00
Keeper's house				5,000.00		5,000.00		5,000.00
Totals				423,988.85		562,920.78		569,591.72

Detailed estimates of cost of locks for 14*-foot project*—Continued.

Item.	Unit.	Price.	Guard lock at Marseilles; land lock; height of walls, 26 feet; rock foundation.		Lock No. 12 at Marseilles; land lock; 8 feet lift; height of walls, 26 feet; rock foundation.		Lock No. 13 at Marseilles; land lock; 9 feet lift; height of walls, 27 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yards	$16.00	13,171	$210,736.00	13,858	$221,728.00	14,776	$236,416.00
Concrete	do	6.00	6,892	41,352.00	6,892	41,352.00	6,948	41,688.00
Timber	M board measure.	27.50	647,757	17,813.32	641,709	17,647.00	641,709	17,647.00
Iron	Pound	.06	33,009	1,980.54	32,379	1,942.74	32,379	1,942.74
Piles	One	6.00						
Gates, valves, etc				26,500.00		25,250.00		25,500.00
Pumping and cofferdam.				5,600.00		5,600.00		5,600.00
Excavation:								
Rock	Cubic yards	1.50	15,000	22,500.00	26,200	39,300.00	26,200	39,300.00
Hard pan	do	.60						
Earth	do	.30						
Grading	do	.30	16,500	4,950.00	9,400	2,820.00	11,300	3,390.00
Keeper's house				5,000.00		5,000.00		5,000.00
Totals				336,431.86		360,639.74		376,483.74

Item.	Unit.	Price.	Lock No. 14, above Ottawa; land lock; 10 feet lift; height of walls, 38 feet; rock foundation.		Lock No. 15, at Lover's Leap; land lock; 7 feet lift; height of walls 37 feet; rock foundation.		Lock No. 16, at Utica; river lock; 8 feet lift; height of walls, 34 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yard	$16.00	24,917	$398,672.00	24,138	$386,208.00	19,191	$307,056.00
Concrete	do	6.00	7,524	45,144.00	7,524	45,124.00	7,304	43,824.00
Timber	M board measure.	27.50	693,402	19,068.56	693,402	19,068.56	659,348	18,132.07
Iron	Pound	.06	38,037	2,282.22	38,037	2,282.22	35,409	2,124.54
Piles	One	6.00						
Gates, valves, etc				28,750.00		29,000.00		27,750.00
Pumping and cofferdam.				33,600.00		5,600.00		33,600.00
Excavation:								
Rock	Cubic yards	6.50	34,300	51,450.00	47,800	71,700.00	39,000	58,500.00
Hard pan	do	.60						
Earth	do	.30						
Grading	do	.30	39,600	11,880.00	26,300	7,890.00	22,500	6,750.00
Keeper's house				5,000.00		5,000.00		5,000.00
Totals				595,846.78		571,892.78		502,736.61

Summaries of the cost of locks for 14-foot project.

Item.	Unit.	Price.	Via Chicago route.		Via Sag route.	
			Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yards	$16.00	323,117	$5,169,872.00	320,822	$5,123,152
Concrete	do	6.00	133,411	800,466.00	133,193	799,158
Timber	M board measure.	27.50	12,592,597	346,296.44	12,446,072	342,267
Iron	Pound	.06	704,167	42,250.62	677,500	40,650
Piles	One	6.00	6,156	36,936.00	3,252	19,512
Gates, valves, etc				497,000.00		496,000
Pumping and coffer-dam.				212,800.00		212,800
Excavation:						
Rock	Cubic yards	1.50	447,700	671,550.00	479,800	719,700
Hard pan	do	.60	51,900	31,140.00	110,500	66,300
Earth	do	.30	195,100	58,530.00	98,000	29,400
Grading	do	.30	412,700	123,810.00	404,100	121,230
Keeper's houses	One	5,000.00	18	90,000.00	18	90,000
Grand total cost of locks				8,080,650.46		8,070,169

Detailed estimates of cost of locks for 8-foot project.

Item.	Unit.	Price.	Guard lock at summit; land lock; height of walls, 20 feet; pile foundation.		Guard lock at Sag Bridge; land lock; height of walls, 17 feet; rock foundation.		Lock No. 1; land lock; 6 feet lift; height of walls, 23 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yards	$16.00	8,985	$143,760.00	7,190	$115,040.00	11,490	$183,840.00
Concrete	do	6.00	6,561	39,366.00	6,403	38,418.00	6,674	40,044.00
Timber	M board measure.	27.50	715,674	19,681.04	597,639	16,435.07	625,704	17,206.86
Iron	Pound	.06	54,292	3,257.52	29,424	1,765.44	32,292	1,937.52
Piles	One	6.00	2,544	15,264.00				
Gates, valves, etc				24,500.00		23,500.00		24,500.00
Pumping and coffer-dam				5,600.00		5,600.00		5,600.00
Excavation:								
Rock	Cubic yards	1.50			15,000	22,500.00	26,000	39,000.00
Hard pan	do	.60			58,600	35,160.00		
Earth	do	.30	72,300	21,690.00				
Grading	do	.30	19,000	5,700.00	16,300	4,890.00	20,400	6,120.00
Keepers' house				5,000.00		5,000.00		5,000.00
Totals				283,818.56		268,308.51		323,248.38

Detailed estimates of cost of locks for 8-foot project—Continued.

Item.	Unit.	Price.	Lock No. 2; river lock; 10 feet lift; height of walls, 22 feet; rock foundation.		Lock No. 3; river lock; 10 feet lift; height of walls, 22 feet; rock foundation.		Lock No. 4; river lock; 11½ feet lift; height of walls, 24 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yards.	$16.00	10,312	$164,992.00	10,312	$164,992.00	11,751	$188,016.00
Concrete	do	6.00	6,700	40,200.00	6,700	40,200.00	6,786	40,716.00
Timber	M board measure	27.50	615,380	16,922.95	615,380	16,922.95	622,078	17,107.15
Iron	Pounds	.06	31,268	1,876.08	31,268	1,876.08	32,084	1,925.04
Piles	One	6.00						
Gates, valves, etc				24,000.00		24,000.00		24,500.00
Pumping and cofferdam				5,600.00		5,600.00		5,600.00
Excavation:								
Rock	Cubic yards.	1.50	28,300	42,450.00	24,700	37,050.00	19,900	29,850.00
Hard pan	do	.60						
Earth	do	.30						
Grading	do	.30	9,400	2,820.00	11,200	3,360.00	10,600	3,180.00
Keeper's house				5,000.00		5,000.00		5,000.00
Totals				303,861.03		299,001.03		315,894.19

Item.	Unit.	Price.	Lock No. 5, at Joliet; river lock; 12 feet lift; height of walls, 24 feet; rock foundation.		Guard lock at Joliet; land lock; height of walls, 17 feet; rock foundation.		Lock No. 6; land lock; 11 feet lift; height of walls, 23 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yard.	$16.00	11,780	$188,480.00	7,190	$115,040.00	11,777	$188,432.00
Concrete	do	6.00	6,786	40,716.00	6,403	38,418.00	6,674	40,044.00
Timber	M board measure.	27.50	622,078	17,107.15	597,639	16,435.07	625,704	17,206.86
Iron	Pound	.06	32,084	1,925.04	29,424	1,765.44	32,292	1,937.52
Piles	One	6.00						
Gates, valves, etc				24,500.00		23,500.00		24,250.00
Pumping and cofferdam.				33,600.00		5,600.00		5,600.00
Excavation:								
Rock	Cubic yard.	1.50	52,000	78,000.00	26,700	40,050.00	30,000	45,000.00
Hard pan	do	.60						
Earth	do	.30						
Grading	do	.30	6,600	1,980.00	13,900	4,170.00	20,900	6,270.00
Keeper's house				5,000.00		5,000.00		5,000.00
Totals				391,308.19		249,978.51		333,740.38

Detailed estimates of cost of locks for 8-foot project—Continued.

Item.	Unit.	Price.	Lock No. 7; land lock; 11 feet lift; height of walls, 23 feet; rock foundation.		Lock No. 8, at Treat's Island; land lock; 10 feet lift; height of walls, 26 feet; rock foundation.		Lock No. 9, above mouth of Kankakee River; land lock; 8 feet lift; height of wall, 32 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yard	$16.00	11,777	$188,432.00	13,973	$223,568.00	19,201	$307,216.00
Concrete	do	6.00	6,674	40,044.00	6,892	41,352.00	7,238	43,428.00
Timber	M board measure.	27.50	625,704	17,206.86	641,709	17,647.00	664,484	18,273.31
Iron	Pound	.06	32,292	1,937.52	32,379	1,942.74	35,199	2,111.94
Piles	One	6.00						
Gates, valves, etc				24,250.00		24,750.00		27,250.00
Pumping and cofferdam.				5,600.00		5,600.00		5,600.00
Excavation:								
Rock	Cubic yard	1.50			4,000	6,000.00	20,000	30,000.00
Hard pan	do	.60	31,200	18,720.00				
Earth	do	.30			28,000	8,400.00	11,000	3,300.00
Grading	do	.30	21,500	6,450.00	23,800	7,140.00	29,000	8,700.00
Keeper's house				5,000.00		5,000.00		5,000.00
Totals				307,640.38		341,399.74		450,879.25

Item.	Unit.	Price.	Lock No. 10 below mouth of Kankakee River; river lock 6 feet lift; height of walls, 33 feet; rock foundation.		Lock No. 11, at Sugar Island; land lock; 4 feet height of walls, 24 feet; pile foundation.		Guard lock, Marseilles, land lock; height of walls, 20 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yard	$16.00	18,159	$290,544.00	12,213	$195,408.00	8,985	$143,760.00
Concrete	do	6.00	7,238	43,428.00	6,850	41,154.00	6,561	39,366.00
Timber	M board measure.	27.50	658,873	18,119.01	771,277	21,210.12	606,354	16,674.74
Iron	Pound	.06	35,385	2,123.10	58,899	3,533.94	30,132	1,807.92
Piles	One	6.00			2,904	17,424.00		
Gates, valves, etc				27,750.00		25,250.00		24,500.00
Pumping and cofferdam.				33,600.00		5,600.00		5,600.00
Excavation:								
Rock	Cubic yard	1.50	23,600	35,400.00			3,000	4,500.00
Hard pan	do	.60						
Earth	do	.30			46,000	13,800.00		
Grading	do	.30	12,300	3,690.00	24,100	7,230.00	16,500	4,950.00
Keeper's house				5,000.00		5,000.00		5,000.00
Totals				459,654.11		335,610.06		246,158.66

Detailed estimates of cost of locks for 8-foot project—Continued.

Item.	Unit.	Price.	Lock No. 12, at Marseilles; land lock; 8 feet lift; height of walls, 20 feet; rock foundation.		Lock No. 13, at Marseilles; land lock; 9 feet lift; height of walls, 21 feet; rock foundation.		Lock No. 14, above Ottawa; land lock; 10 feet lift; height of walls, 32 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yard	$16.00	9,541	$152,656.00	10,364	$165,824.00	19,315	$309,040.00
Concrete	do	6.00	6,561	39,366.00	6,625	39,750.00	7,238	43,428.00
Timber	M board measure.	27.50	600,306	16,508.42	601,170	16,532.18	664,484	18,273.31
Iron	Pound	.06	29,502	1,770.12	29,536	1,772.16	35,199	2,111.94
Piles	One	6.00						
Gates, valves, etc				23,750.00		24,000.00		26,750.00
Pumping and cofferdam.				5,600.00		5,600.00		33,600.00
Excavation:								
Rock	Cubic yard	1.50	14,200	21,300.00	14,200	21,300.00	22,300	33,450.00
Hard pan	do	.60						
Earth	do	.30						
Grading	do	.30	8,000	2,400.00	10,000	3,000.00	39,600	11,880.00
Keeper's house				5,000.00		5,000.00		5,000.00
Totals				268,350.54		282,778.34		483,533.25

Item.	Unit.	Price.	Lock No. 15, at Lover's Leap; land lock; 7 feet lift; height of walls, 31 feet; rock foundation.		Lock No. 16, at Utica; river lock; 8 feet lift; height of walls, 28 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yard	$16.00	18,175	$290,800.00	14,157	$226,512.00
Concrete	do	6.00	7,238	43,428.00	6,949	41,694.00
Timber	M board measure	27.50	664,484	18,273.31	643,739	17,702.82
Iron	Pound	.06	35,199	2,111.94	32,972	1,978.32
Piles	One	6.00				
Gates, valves, etc				27,000.00		25,750.00
Pumping and cofferdam.				5,600.00		33,600.00
Excavation:						
Rock	Cubic yard	1.50	35,800	53,700.00	27,000	40,500.00
Hard pan	do	.60				
Earth	do	.30				
Grading	do	.30	27,000	8,100.00	22,700	6,810.00
Keeper's house				5,000.00		5,000.00
Totals				454,013.25		399,547.14

Summaries of the cost of locks for 8-foot project.

Item.	Unit.	Price.	Via Chicago route.		Via Sag route.	
			Quantities.	Cost.	Quantities.	Cost.
Masonry	Cubic yard	$16.00	249,457	$3,831,312.00	237,662	$3,802,592.00
Concrete	do	6.00	129,357	776,142.00	129,199	775,194.00
Timber	M board measure	27.50	12,182,221	335,011.11	12,064,186	331,765.14
Iron	Pound	.06	661,698	39,701.88	636,830	38,209.80
Piles	One	6.00	5,448	32,688.00	2,904	17,424.00
Gates, valves, etc				474,750.00		473,750.00
Pumping and coffer-dam.				218,400.00		218,400.00
Excavation:						
Rock	Cubic yard	1.50	371,700	557,550.00	386,700	580,050.00
Hard pan	do	.60	31,200	18,720.00	89,800	53,880.00
Earth	do	.30	157,300	47,190.00	85,000	25,500.00
Grading	do	.30	346,500	103,950.00	343,800	103,140.00
Keeper's house	One	5,000.00	19	95,000.00	19	95,000.00
Grand total cost of locks.				6,530,414.99		6,514,904.94

Detailed estimates of cost of dams for both projects.

Item.	Unit.	Price.	Dam at Treat's Island; Length of weir, 590 ft.; heights of weir, 4, 10, and 16 feet; width, 72 feet; hard-pan foundation.		Dam above mouth of Kankakee River: Length of weir, 520 ft.; heights of weir, 3 and 13 feet; width, 42 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.
Timber	M board measure.	$40.00	1,362,900	$54,516.00	591,600	$23,664.00
Iron	Pound	.06	69,655	4,179.30	28,107	1,686.42
Stone filling	Cubic yard	2.00	13,461	26,922.00	5,414	10,828.00
Masonry	do	16.00	607	9,712.00	160	2,560.00
Rock excavation	do	3.00	67	201.00	3,322	9,966.00
Earth excavation	do	.50	13,613	6,806.50	1,295	647.50
Back filling	do	.50	9,833	4,916.50	5,692	2,846.00
Levees	do	.30	29,100	8,730.00	8,000	2,400.00
Coffer-dam	Foot	20.00	1,180	23,600.00	1,040	20,800.00
Totals				139,583.30		75,397.92

Item.	Unit.	Price.	Dam below mouth of Kankakee River: Length of weir, 640 ft.; heights of weir, 8 and 16 feet; width, 48 feet; rock foundation.		Dam at Sugar Island: Length of weir, 494 ft.; length of wicket, 300 feet; heights of weir, 5 and 11 feet; height of wicket, 6 ft.; width, 33 feet; piles foundation.	
			Quantities.	Cost.	Quantities.	Cost.
Timber	M board measure.	$40.00	1,140,480	$45,619.20	711,624	$28,464.96
Iron	Pound	.06	61,828	3,709.68	31,311	1,878.66
Stone filling	Cubic yard	2.00	11,072	22,144.00	6,677	13,354.00
Masonry	do	16.00	192	3,072.00	175	2,800.00
Rock excavation	do	3.00	3,324	9,972.00		
Earth excavation	do	.50	8,752	4,376.00	8,295	4,147.50
Back filling	do	.50	10,667	5,333.50	4,215	2,107.50
Levees	do	.30	2,200	660.00	5,500	1,650.00
Coffer-dam	Foot	20.00	1,280	25,600.00	1,600	32,000.00
Navigable pass						25,500.00
Piles	One	10.00			737	7,370.00
Totals				120,486.28		119,272.62

Detailed estimates of cost of dams for both projects—Continued.

Item.	Unit.	Price.	Dam at Marseilles: Length of weir, 750 feet; heights of weir, 4 and 13 feet; width, 42 feet; rock foundation.		Dam at Ottawa: Length of weir, 1,400 feet; heights of weir, 3, 9, and 15 feet; width, 67½ feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.
Timber	M board measure.	$40.00	852,000	$34,080.00	2,015,100	$80,604.00
Iron	Pound	.06	40,453	2,427.18	88,920	5,335.20
Stone filling	Cubic yard	2.00	7,815	15,630.00	19,672	39,344.00
Masonry	....do	16.00	498	7,968.00	552	8,832.00
Rock excavation	....do	3.00	2,900	8,700.00	4,849	14,547.00
Earth excavation	....do	.50			460	230.00
Back filling	....do	.50	7,611	3,805.50	14,119	7,059.50
Levees	....do	.30	800	240.00	2,400	720.00
Coffer-dam	Foot	20.00	1,500	30,000.00	1,660	33,200.00
Totals				102,850.68		189,871.70

Item.	Unit.	Price.	Dam at Lover's Leap: Length of weir, 1,020 feet; heights of weir, 6 and 15 feet; width, 45 feet; rock foundation.		Dam at Utica: Length of weir, 194 feet; length of wicket, 300 ft.; heights of weir, 10 and 18 feet; height of wicket, 12 ft.; width, 54 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.
Timber	M board measure.	$40.00	1,395,360	$55,814.40	757,980	$30,319.20
Iron	Pound	.06	68,896	4,133.76	36,134	2,168.04
Stone filling	Cubic yard	2.00	14,903	29,806.00	7,498	14,996.00
Masonry	....do	16.00	113	1,808.00	676	10,816.00
Rock excavation	....do	3.00	5,646	16,938.00	2,872	8,616.00
Earth excavation	....do	.50	3,992	1,996.00	7,265	3,632.50
Back filling	....do	.50	14,809	7,404.50	4,953	2,476.50
Levees	....do	.30	108,900	32,670.00	71,000	21,300.00
Coffer-dam	Foot	20.00	2,040	40,800.00	1,000	20,000.00
Navigable pass						60,000.00
Totals				191,370.66		174,324.24

Detailed estimates of cost of dams.

Item.	Unit.	Price.	14-foot project.			
			Waste gates at Lockport: Length of weir, 300 feet; length of wicket, 200 feet; height of weir, 14 feet; height of wicket, 12 feet; width, 25 feet; rock foundation.		Dam at Joliet: Length of weir, 124 feet; length of wicket, 75 feet; heights of weir, 8 and 16 feet; height of wicket, 10 feet; width, 48 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.
Timber	M board measure.	$40.00			304,668	$12,186.72
Iron	Pound	.06			15,601	936.06
Stone filling	Cubic yard	2.00			2,781	5,562.00
Masonry	....do	16.00	3,638	$58,208.00	358	5,728.00
Rock excavation	....do	3.00	344	1,032.00	1,454	4,362.00
Earth excavation	....do	.50				
Back filling	....do	.50	3,430	1,715.00	2,267	1,133.50
Levees	....do	.30				
Coffer-dam	Foot	20.00			400	8,000.00
Sluiceways	....do			12,000.00		15,000.00
Totals				72,955.00		52,908.28

Detailed estimates of cost of dams—Continued.

Item.	Unit.	Price.	8-foot project.			
			Waste gates at Lockport: Length of weir, 300 feet; length of wicket, 200 ft.; height of weir, 11 ft; height of wicket, 12 feet width, 25 feet; rock foundation.		Dam at Joliet: Length of weir, 94 feet; length of wicket, 100 ft.; height of weir, 10 feet; height of wicket, 7 feet; width, 30 feet; rock foundation.	
			Quantities.	Cost.	Quantities.	Cost.
Timber	M board measure	$40.00			141,912	$5,676.48
Iron	Pound	.06			6,788	407.28
Stone filling	Cubic yard	2.00			890	1,780.00
Masonry	....do	16.00	1,878	$30,048.00	134	2,144.00
Rock excavation	....do	3.00	6,222	18,666.00	1,097	3,291.00
Earth excavation	....do	.50				
Back filling	....do	.50	1,878	939.00	631	315.50
Levees	....do	.30				
Coffer-dam	Foot	20.00			400	8,000.00
Sluiceways	....do			12,000.00		8,500.00
Totals				61,653.00		30,114.26

Summaries of the cost of dams.

Item.	Unit.	Price.	14-foot project.		8-foot project.	
			Quantities.	Cost.	Quantities.	Cost.
Timber	M board measure	$40.00	9,131,712	$365,268.48	8,968,956	$358,758.24
Iron	Pound	.06	440,905	26,454.30	432,092	25,925.52
Stone filling	Cubic yard	2.00	89,293	178,586.00	87,402	174,804.00
Masonry	....do	16.00	6,969	111,504.00	4,985	79,760.00
Rock excavation	....do	3.00	24,778	74,334.00	30,299	90,897.00
Earth excavation	....do	.50	43,672	21,836.00	43,672	21,836.00
Back filling	....do	.50	77,596	38,798.00	74,408	37,204.00
Levees	....do	.30	227,900	68,370.00	227,900	68,370.00
Coffer-dams	Foot	20.00	11,700	234,000.00	11,700	234,000.00
Movable part				112,500.00		106,000.00
Piles	One	10.00	737	7,370.00	737	7,370.00
Grand total cost of dams				1,239,020.78		1,204,924.76

BORINGS ALONG CHICAGO ROUTE.

BORING No. 15.

[Located 600 feet north and 300 feet east of the southwest corner of section 30, township 39 north, range 14 east, in the city of Chicago, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Loam	2.0	2.0	Elevation of surface of ground, 160.1 feet; commenced boring 11 a.m. April 18, 1889; completed boring, 2.30 p.m. April 19, 1889; depth bored, 30.2 feet; time, 5 hours 45 minutes; depth required, 26.6 feet.
2	Yellow and blue clay	5.0	3.0	
3	Blue clay and gravel	15.0	10.0	
4	Gravel and sand	19.0	4.0	
5	Quicksand and gravel	30.2	11.2	

Borings along Chicago Route—Continued.

BORING No. 16.

[Located 2,000 feet west and 300 feet south of the northeast corner of section 36, township 39 north, range 13 east, in the city of Chicago, Cook County, Ill.]

No		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Loam	1.0	1.0	Elevation of surface of ground, 169.2 feet; commenced boring, 1.45 p. m. April 18, 1889; completed boring, 12.05 p. m. April 19, 1889; depth bored, 30.5 feet; time, 5 hours 15 minutes; depth required, 26.9 feet.
2	Yellow clay	9.0	8.0	
3	Blue clay and gravel	18.0	9.0	
4	Quicksand	20.5	2.5	
5	Blue clay and gravel	30.5	10.0	

BORING No. 17.

[Located 1,300 eet south and 800 feet east of the northwest corner of section 36, township 39 north, range 13 east, in the city of Chicago, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	2.0	2.0	Elevation of surface of ground, 162.8 feet; commenced boring, 4 p. m. April 17, 1889; completed boring, 12 m. April 18, 1889; depth bored, 30.6 feet; time, 4 hours 45 minutes; depth required, 29.5 feet.
2	Clay and gravel	8.0	6.0	
3	Quicksand and gravel	12.5	4.5	
4	Blue clay	30.6	18.1	

BORING No. 18.

[Located 2,200 feet south and 1,600 feet west of the northeast corner of section 35, township 39 north, range 13 east, in the city of Chicago, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	2.0	2.0	Elevation of surface of ground, 162 feet; commenced boring, 1 p. m. April 17, 1889; completed boring, 8.50 a. m. April 18, 1889; depth bored, 29.5 feet; time, 4 hours 20 minutes.
2	Yellow and blue clay	5.5	3.5	
3	Blue clay and gravel	22.0	16.5	
4	Gravel	24.0	2.0	
5	Blue clay and gravel	29.5	5.5	

BORING No. 19.

[Located 2,200 feet north and 1,300 feet east of the southwest corner of section 35, township 39 north, range 13 east, in the city of Chicago, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	1.0	1.0	Elevation of surface of ground, 163.3 feet; commenced boring, 8.15 a. m. April 17, 1889; completed boring, 1.45 p. m. April 17, 1889; depth bored, 31 feet; time, 4 hours and 55 minutes; depth required, 30 feet.
2	Yellow clay and gravel	4.0	3.0	
3	Blue clay and gravel	31.0	27.0	

BORING No. 20.

[Located 1,100 feet north and 1,100 feet west of the southeast corner of section 34, township 39 north, range 13 east, in the city of Chicago, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	1.0	1.0	Elevation of surface of ground, 164 feet; commenced boring, 1.30 p. m. April 16, 1889; completed boring, 9.05 a. m. April 17, 1889; depth bored, 31.4 feet; time, 5 hours; depth required, 30.9 feet.
2	Yellow and blue clay	6.0	5.0	
3	Blue clay and gravel	31.4	25.4	

BORING No. 21.

[Located about 475 feet east of the Belt Line Rwy. and 800 feet north of the C., St. F. and C. R. R., 1,800 feet east and 200 feet north of the southwest corner of section 34, township 39 north, range 13 east, in the city of Chicago, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	3.0	3.0	Elevation of surface of ground, 165.2 feet; commenced boring, 9 a. m. April 16, 1889; completed boring, 1.30 p. m. April 16, 1889; depth bored, 33.1 feet; time, 4 hours; depth required 32.1 feet.
2	Yellow and blue clay	8.0	5.0	
3	Blue clay and gravel	33.1	25.1	

BORINGS ALONG CHICAGO ROUTE—Continued.

BORING No. 22.

[Located 600 feet south and 600 feet west of the northeast corner of section 4, township 38 north, range 13 east in Lyons Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Loam	1.0	1.0	Elevation of surface of ground 164.9 feet; commenced boring, 10.45 a. m., April 15, 1889; completed boring, 11.10 a. m., April 16, 1889; depth bored, 35. feet; time, 7 hours 40 minutes.
2	Sand	4.0	3.0	
3	Yellow and blue clay	7.0	3.0	
4	Blue clay	35.0	28.0	

BORING No. 23.

[Located 1,900 feet south and 2,560 feet east of the northwest corner of section 4, township 38 north, range 13 east, in Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	2.5	2.5	Elevation of surface of ground, 165.1 feet; commenced boring, 7.30 a. m. April 13, 1889; completed boring, 11.20 a. m. April 13, 1889; depth bored, 32.5 feet; time, 3 hours 50 minutes; depth required, 32.1 feet.
2	Yellow clay	6.5	4.0	
3	Soft blue clay	32.5	26.0	

BORING No. 24.

[Located 30 feet west of north and south highway, 800 feet from center of the C., St. F. and C. R. R., 25 feet west and 2,500 feet north of the southeast corner of section 5, township 38 north, range 13 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	0.7	0.7	Elevation of surface of ground, 164.1 feet; commenced boring, 4.20 p. m, April 11, 1889; completed boring, 8.45 a. m. April 13, 1889; depth bored, 31.1 feet; time, 4 hours 25 minutes.
2	Yellow clay and gravel	7.0	6.3	
3	Blue clay and gravel	31.1	24.1	

BORING No. 25.

[Located 2,500 feet west and 1,500 feet north of the southeast corner of section 5, township 38 north, range 13 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	2.5	2.5	Elevation of surface of ground, 162 feet; commenced boring, 9.30 a. m. April 11, 1889; completed boring, 2.50 p. m. April 11, 1889; depth bored, 31.2 feet; time, 4 hours 15 minutes; depth required, 29.2 feet.
2	Yellow clay	9.7	7.2	
3	Blue clay	31.2	21.5	

BORING No. 26.

[Located 600 feet north and 400 feet east of the southwest corner of section 5, township 38 north, range 13 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	1.5	1.5	Elevation of surface of ground, 162.5 feet; commenced boring, 3.30 p. m. April 10, 1889; completed boring, 2.50 p. m. April 11, 1889; depth bored, 31 feet; time, 8 hours 9 minutes; depth required, 29.7 feet.
2	Sandy, yellow clay	9.5	8.0	
3	Blue clay	31.0	21.5	

BORING No. 27.

Located 2,100 feet west and 900 feet south of the northeast corner of section 7, township 38 north, range 13 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	1.5	1.5	Elevation of surface of ground, 162.5 feet; commenced boring, 4.50 p. m. April 9, 1889; completed boring, 4.55 p. m. April 10, 1889; depth bored, 30.4 feet; time, 9 hours 5 minutes; depth required, 29.3 feet.
2	Sandy, yellow clay	4.0	2.5	
3	Yellow clay	9.7	5.7	
4	Blue clay	22.0	12.3	
5	Blue clay and gravel	30.4	8.4	

Borings Along Chicago Route—Continued.

BORING No. 28.

[Located 2,200 feet south and 800 feet east of the northwest corner of section 7, township 38 north, range 13 east, Lyons Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Loam	2.5	2.5	Elevation of surface of ground, 161.9 feet; commenced boring, 2 p. m., April 8, 1889; completed boring, 3.45 p. m. April 9, 1889; depth bored, 31 feet; time 10 hours, 30 minutes; depth required, 29.1 feet.
2	Sand and yellow clay	4.5	2.0	
3	Yellow clay	8.5	4.00	
4	Hard blue clay and gravel	31.0	22.5	

BORING No. 29.

[Located 1,900 feet west and 2,100 feet north of the southeast corner of section 12, township 38 north, range 12 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	1.5	1.5	Elevation of surface of ground, 162.2 feet; commenced boring, 10.30 a. m. April 5, 1889; completed boring, 5.40 p. m. April 9, 1889; depth bored, 27.7 feet; time, 13 hours 5 minutes; depth drilled, 3 feet; time, 15 hours 20 minutes.
2	Fine gravel and sand	10.0	8.5	
3	Blue clay	20.8	10.8	
4	Bowlder	22.5	1.7	
5	Blue clay	23.6	1.1	
6	Bowlder	24.9	1.3	
7	Blue clay	30.7	5.8	

BORING No. 30.

[Located 800 feet north and 1,800 feet east of the southwest corner of section 12, township 38 north, range 12 east, and 37 feet northeast of highway and 300 feet northwest of canal bridge at Summit, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	1.1	1.1	Elevation of surface of ground, 162.6 feet; commenced boring, 10.05 a. m. April 8, 1889; completed boring, 5.30 p. m. April 9, 1889; depth bored, 30.9 feet; time, 7 hours 44 minutes; depth drilled, 3.1 feet; time, 2 hours 30 minutes; depth required, 30 feet.
2	Yellow clay	6.1	5.0	
3	Blue clay	22.4	16.3	
4	Quicksand	24.4	2.0	
5	Bowlders	27.5	3.1	
6	Clay	34.0	6.5	

BORING No. 31.

[Located 400 feet east and 300 feet south of the northwest corner of section 13, township 38 north, range 12 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Black soil	1.0	1.0	Elevation of surface of ground, 162 5 feet; commenced boring, 11.15 a. m. April 10, 1889; completed boring, 11.30 a. m. April 11, 1889; depth bored, 27 2 feet; time, 5 hours, 35 minutes; drilled, 4.8 feet; time, 2 hours 45 minutes; depth required, 30 feet.
2	Yellow clay	3.0	2.0	
3	Blue clay	10.0	7.0	
4	Bowlders	14.8	4.8	
5	Blue clay	32.0	17.2	

BORING No. 32.

[Located 125 feet northwest of the Illinois and Michigan Canal and 35 feet west of the west corner of Swift & Co.'s stock-yards, 1,200 feet west and 1,900 feet north of the southeast corner of section 14, township 38 north, range 12 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Clay	1.0	1.0	Elevation of surface of ground, 163.6 feet; commenced boring, 8 a. m. April 12, 1889; completed boring, 6 20 p. m., April 13, 1889; depth bored, 27.8 feet; time, 8 hours 30 minutes; depth drilled, 3.1 feet; time, 2 hours 45 minutes.
2	Black soil	2.5	1.5	
3	Hard blue clay	9.8	7.3	
4	Bowlder	12.3	2.5	
5	Hard blue clay	30.3	18.0	
6	Bowlder	30.9	0.6	

Borings Along Chicago Route—Continued.

BORING No. 33.

[Located 2,700 feet west and 100 feet south of the northeast corner of section 23, township 38 north, range 12 east, Lyons Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Yellow sand	0.9	0.9	Elevation of surface of ground, 163.1 feet; commenced boring, 9.35 a. m. April 16, 1889; completed boring, 11.51 a. m. April 18, 1889; depth bored, 12.2 feet; time, 45 minutes; depth drilled, 18.4 feet; time, 17 hours 47 minutes.
2	Loam	1.9	1.0	
3	Yellow clay	6.7	4.8	
4	Bowlders	15.4	8.7	
5	Blue clay	20.0	4.6	
6	Bowlders	30.6	10.6	

BORING No. 34.

[Located 800 feet east and 2,200 feet south of the northwest corner of section 23, township 38 north, range 12 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Black soil	1.3	1.3	Elevation of surface of ground, 166.3 feet; commenced boring, 9.05 a. m. April 19, 1889; completed boring, 4.05 p. m. April 22, 1889; depth bored, 29.8 feet; time, 7 hours 13 minutes; depth drilled, 4.2 feet; time, 2 hours 15 minutes.
2	Yellow, sandy clay, gravel, and cobble-stones.	7.9	6.6	
3	Quicksand	16.0	8.1	
4	Blue clay	34.0	18.0	

BORING No. 35.

[Located 100 feet from the Illinois and Michigan Canal, 1,000 feet north and 700 feet west of the southeast corner of section 22, township 38 north, range 12 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	1.0	1.0	Elevation of surface of ground, 164.3 feet; commenced boring, 9.30 a. m. April 23, 1889; completed boring, 11.40 a. m. April 24, 1889; depth bored, 27.9 feet; time, 6 hours 22 minutes; depth drilled, 4.7 feet; time, 4 hours 8 minutes.
2	Yellow clay and gravel	5.0	4.0	
3	Bowlders	7.4	2.4	
4	Blue clay and gravel	18.0	10.6	
5	Hard quicksand	23.1	5.1	
6	Blue clay	25.1	2.0	
7	Bowlder	27.4	2.3	
8	Blue clay	32.6	5.2	

BORING No. 36.

[Located 17 feet from the northwest bank of the Illinois and Michigan Canal, 2,200 feet west and 1,200 feet south of the northeast corner of section 27, township 38 north, range 12 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Clay and bowlders	3.0	3.0	Elevation of surface ground, 162.7 feet; commenced boring, 7.30 a. m. April 24, 1889; completed boring, 4.25 p. m. May 2, 1889; depth bored, 7.7 feet; time, 29 hours 45 minutes; depth drilled, 27.8 feet; time, 30 hours 21 minutes.
2	Loam	4.0	1.0	
3	Bowlders	23.8	19.8	
4	Fine, compact gravel	30.5	6.7	

BORING No. 37.

[Located 1,700 feet east and 2,200 feet north of the southwest corner of section 27, township 38 north, range 12 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Sand and clay	3.0	3.0	Elevation of surface of ground, 165.1 feet; commenced boring, 9 a. m. April 23, 1889; completed boring 4.25 p. m. April 25, 1889; depth bored, 27.6 feet; time, 10 hours 15 minutes; depth drilled, 4.3 feet; time, 4 hours 40 minutes.
2	Loam	4.0	1.0	
3	Yellow clay, sand, and gravel	9.5	5.5	
4	Gravel	17.4	7.9	
5	Hard clay, sand, and gravel	20.8	3.4	
6	Bowlder	25.1	4.3	
7	Gravel	26.6	1.5	
8	Quicksand	31.9	5.3	

Borings Along Chicago Route—Continued.

BORING No. 38.

[Located 40 feet from the northwest bank of the Illinois and Michigan Canal, 100 feet west and 400 feet north of the southeast corner of section 28, township 38 north, range 12 east, Lyons Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Clay and sand	1.0	1.0	Elevation of surface of ground, 163.4 feet; commenced boring, 1.30 p. m. May 3, 1889; completed boring, 1.50 p. m. May 4, 1889; depth bored, 28.6 feet: time, 6 hours 36 minutes; depth drilled, 2.9 feet; time, 2 hours 39 minutes.
2	Black soil	2.1	1.1	
3	Yellow clay	6.4	4.3	
4	Blue clay	18.2	11.8	
5	Quicksand	26.7	8.5	
6	Gravel	27.7	1.0	
7	Bowlder	30.6	2.9	
8	Hard quicksand	31.5	0.9	

BORING No. 39.

[Located 15 feet from bank of the Illinois and Michigan Canal, 2,500 feet west and 1,400 feet south of the northeast corner of section 33, township 38 north, range 12 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Sandy clay from waste banks.	1.4	1.4	Elevation of surface ground, 164.7 feet; commenced boring, 1.35 p. m. May 6, 1889; completed boring, 8.28 a. m. May 11, 1889; depth bored, 8.5 feet; time, 1 hour 28 minutes; depth drilled, 24.1 feet; time, 34 hours 31 minutes.
2	Bowlder	1.7	0.3	
3	Black soil	2.6	0.9	
4	Yellow clay	4.5	1.9	
5	Bowlders	31.4	26.9	
6	Gravel	32.6	1.2	

BORING No. 40.

[Located 250 feet northwest of the bank of the Illinois and Michigan Canal, 600 feet east and 2,300 feet north of the southwest corner of section 33, township 38 north, range 12 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Sandy clay from waste bank.	6.0	6.0	Elevation of surface of ground, 164.8 feet; commenced boring, 11.10 a. m. May 13, 1889; completed boring, 4.20 p. m. May 16, 1889; depth bored, 10.4 feet; time, 1 hour 54 minutes; depth drilled, 22.4 feet; time, 27 hours 44 minutes.
2	Black peat	9.8	3.8	
3	Bowlders	23.2	13.4	
4	Gravel	23.8	0.6	
5	Bowlders	32.8	9.0	

BORING No. 41.

[Located 1,400 feet west and 1,200 feet north of the southeast corner of section 32, township 38 north, range 12 east, and 75 feet southeast and 30 feet northeast of the southeast end of wagon bridge over Des Plaines River at Willow Springs, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Black soil	2.5	2.5	Elevation of surface of ground, 163.9 feet; commenced boring, 11 a. m. May 17, 1889; completed boring, 5 51 p. m. May 24, 1889; depth bored, 13.7 feet; time, 10 hours 59 minutes; depth drilled, 17.4 feet; time 40 hours 52 minutes.
2	Blue clay	8.0	5.5	
3	Peat	12.2	4.2	
4	Soft blue clay	13.0	0.8	
5	Bowlders	21.3	8.3	
6	Fine gravel	22.0	0.7	
7	Bowlders	26.0	4.0	
8	Limestone rock	31.1	5.1	

BORING No. 42.

[Located on the west bank of the Des Plaines River, 1,800 feet east and 100 feet south of the northwest corner of section 5, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Black soil	1.4	1.4	Elevation of surface of ground, 163 feet; commenced boring, 10.33 a. m. May 27, 1889; completed boring, 3.14 p. m. June 1, 1889; depth bored, 22.6 feet; time, 18 hours 13 minutes; depth drilled, 8.7 feet; time, 10 hours 55 minutes.
2	Yellow clay	10.5	9.1	
3	Blue clay and gravel	12.0	1.5	
4	Bowlders in blue clay	16.6	4.6	
5	Fine gravel	21.9	5.3	
6	Bowlders in blue clay	26.0	4.1	
7	Fine gravel	30.0	4.0	
8	Sand (quicksand)	31.3	1.3	

Borings Along Chicago Route—Continued.

BORING No. 43.

[Located 275 feet southeast of the center of C. St. F. and C. R. R. track, 1,800 feet south and 158 feet west of the northeast corner of section 6, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Loam	0.6	0.6	Elevation of surface of ground, 165.9 feet; commenced boring, 2 p. m. June 3, 1889; completed boring, 3.20 p. m. June 10, 1889; depth bored, 11 feet; time, 21 hours, 30 minutes; depth drilled, 23 feet; time, 28 hours 2 minutes.
2	Gravel	11.4	10.8	
3	Bowlders and clay	30.5	19.1	
4	Limestone rock	34.0	3.5	

BORING No. 44.

[Located on the northwest bank of the Des Plaines River, 2,400 feet west and 2,000 feet north of the southeast corner of section 6, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	0.4	0.4	Elevation of surface of ground, 163.2 feet; commenced boring, 2.30 p. m. June 5, 1889; completed boring, 10.30 a. m. June 13, 1889; depth bored, 14.6 feet; time, 8 hours 50 minutes; depth drilled, 11 feet; time, 36 hours 24 minutes.
2	Fine gravel	7.3	6.9	
3	Blue clay and gravel	8.8	1.5	
4	Sand and gravel	9.6	0.8	
5	Bowlder	11.2	1.6	
6	Hard blue clay and cobble-stones.	15.2	4.0	
7	Soft blue clay and gravel	17.2	2.0	
8	Bowlders	19.8	2.6	
9	Soft blue clay and fine gravel.	20.8	1.0	
10	Bowlder	22.3	1.5	
11	Limestone rock	25.6	3.3	

BORING No. 45.

[Located on the northwest side of the Des Plaines River, 1,100 feet north and 1,100 feet east of the southwest corner of section 6, township 37 north, range 12 east, Palas Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	0.3	0.3	Elevation of surface of ground, 163.5 feet; commenced boring, 3.45 p. m. June 17, 1889; completed boring, 9.30 a. m. June 22, 1889; depth bored, 18.2 feet; time, 10 hours 10 minutes; depth drilled, 8.3 feet; time, 23 hours 25 minutes.
2	Cobble-stones and yellow clay	5.5	5.2	
3	Blue clay	10.5	5.0	
4	Fine gravel	13.8	3.3	
5	Quicksand and gravel	18.0	4.2	
6	Quicksand and cobble-stones	20.5	2.5	
7	Limestone rock	26.5	6.0	

BORING No. 46.

[Located in the Des Plaines River, 400 feet west and 3,400 feet north of the southeast corner of section 32, township 38 north, range 12 east, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Water	5.5	5.5	Elevation of surface of water, 163.1 feet; commenced boring, 11.30 a. m. June 25, 1889; completed boring, 11.05 a. m. June 28, 1889; depth bored, 27.1 feet; time, 9 hours 5 minutes; depth drilled, 4.1 feet; time, 11 hours 15 minutes.
2	Mud	14.5	9.0	
3	Soft blue clay	18.2	3.7	
4	Bowlder	20.7	2.5	
5	Sand	23.0	2.3	
6	Bowlder	24.6	1.6	
7	Fine gravel, with sand and blue clay	27.6	3.0	
8	Hard blue clay, with some fine gravel	31.2	3.6	

BORINGS ALONG CHICAGO ROUTE—Continued.

BORING No. 47.

[Located in the Des Plaines River, 2,400 feet west and 1,600 feet north of the southeast corner of section 6, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Water	6.0	6.0	Elevation of surface of water, 163.1 feet; commenced boring, 10.15 a. m. June 29, 1889; completed boring, 1.40 p. m. July 5, 1889; depth bored, 27.1 feet; time, 12 hours 5 minutes; depth drilled, 4.2 feet; time, 15 hours 25 minutes.
2	Mud	16.1	10.1	
3	Cobble-stones	18.9	2.8	
4	Bowlder	19.6	0.7	
5	Blue clay	21.0	1.4	
6	Clay and gravel	25.5	4.5	
7	Quicksand and gravel	29.3	3.8	
8	Limestone rock	31.3	2.0	

BORING No. 48.

[Located in the Des Plaines River, 50 feet from the north bank, 200 feet west and 2,200 feet north of the southeast corner of section 6, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Water	9.0	9.0	Elevation of surface of water, 163 feet; commenced boring, 4.30 p. m. July 5, 1889; completed boring, 5.30 p. m. July 12, 1889; depth bored, 19.9 feet; time, 9 hours 45 minutes; depth drilled, 8.4 feet; time, 37 hours 25 minutes.
2	Mud	13.0	4.0	
3	Gravel and quicksand	18.0	5.0	
4	Cobble-stones and bowlders	19.3	1.3	
5	Clay and coarse gravel	21.2	1.9	
6	Limestone rock	28.3	7.1	

BORING No. 49.

[Located 1,300 feet west and 1,200 feet north of the southeast corner of section 32, township 38 north range 12 east, in the Des Plaines River, 10 feet below the northwest pier and 80 feet from the northwest abutment of wagon bridge over the Des Plaines River at Willow Springs, Lyons Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Water	3.5	3.5	Elevation of surface of water, 162.8 feet; commenced boring, 7 a. m. July 9, 1889; completed boring, 1.30 p. m. July 11, 1889; depth bored, 28.7 feet; time, 13 hours 30 minutes; depth drilled, 4 feet; time, 11 hours 25 minutes.
2	Mud	10.0	6.5	
3	Gravel	11.3	1.3	
4	Cobble-stones	19.5	8.2	
5	Gravel	20.0	0.5	
6	Cobble-stones	24.8	4.8	
7	Gravel	32.7	7.9	

BORING No. 50.

[Located in the Des Plaines River, 1,000 feet east and 2,500 feet south of the northwest corner of section 5, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Water	6.0	6.0	Elevation of surface of water, 163 feet; commenced boring, 7 a. m. July 12, 1889; completed boring, 3.15 p. m. July 16, 1889; depth bored, 19 feet; time, 3 hours; depth drilled, 7.8 feet; time, 19 hours 30 minutes.
2	Mud	16.0	10.0	
3	Cobble-stones	21.2	5.2	
4	Limestone rock	26.8	5.6	

BORING No. 51.

[Located in the Des Plaines River, 300 feet north and 1,300 feet east of the southwest corner of section 6, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Water	8.0	8.0	Elevation of surface of water, 162.9 feet; commenced boring, 9.30 a. m. July 15, 1889; completed boring, 5.30 p. m. July 19, 1889; depth bored, 23 feet; time, 15 hours 50 minutes; depth drilled, 4.1 feet; time, 17 hours.
2	Mud	14.5	6.5	
3	Cobblestones and fine gravel	23.0	8.5	
4	Limestone rock	27.1	4.1	

BORINGS ALONG CHICAGO ROUTE—Continued.

BORING No. 52.

[Located in the Des Plaines River, 100 feet south and 1,300 feet west of the northeast corner of section 12, township 37 north, range 11 east, on the line between Downers Grove Township, Du Page County, and Lemont Township, Cook County, Ill.*]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Water	8.7	8.7	Elevation of surface of water, 162.8 feet; commenced boring, 10 a.m. July 17, 1889; completed boring, 12 m. July 23, 1889; depth bored, 11.3 feet; time, 2 hours 15 minutes; depth drilled, 7.8 feet; time, 24 hours 5 minutes.
2	Gravel	9.2	0.5	
3	Clay	10.2	1.0	
4	Bowlder	13.4	3.2	
5	Sand and gravel	14.5	1.1	
6	Limestone rock	19.1	4.6	

*NOTE.—The Des Plaines River through sections 11, 12, 14, 15, and 16, township 37 north, range 11 east, forms the boundary line between Downers Grove Township, Du Page County, and Lemont Township, Cook County, Ill.

BORING No. 53.

[Located in the Des Plaines River, 1,600 feet east and 1,400 feet south of the northwest corner of section 12, township 37 north, range 11 east, on the line between Du Page and Cook counties, Ill.]

		Feet.	*Feet.*	
1	Water	5.0	5.0	Elevation of surface of water, 163.2 feet; commenced boring, 3 p. m. July 20, 1889; completed boring, 2.30 p. m. July 27, 1889; depth bored, 26.2 feet; time, 28 hours 45 minutes; depth drilled, 2.4 feet; time, 6 hours 30 minutes.
2	Mud	9.5	4.5	
3	Sand and gravel	15.4	5.9	
4	Cobble-stones, sand, and gravel.	26.2	10.8	
5	Limestone rock	28.6	2.4	

BORING No. 54.

[Located in the Des Plaines River, 300 feet west and 2,300 feet north of the southeast corner of section 11, township 37 north, range 11 east, on the line between Du Page and Cook counties, Ill.]

		Feet.	*Feet.*	
1	Water	7.1	7.1	Elevation of surface of water 162.7 feet; commenced boring, 4.10 p. m. July 23, 1889; completed boring, 5.30 p. m. July 24, 1889; depth bored, 7.3 feet; time 5 minutes; depth drilled, 8 feet; time, 10 hours 45 minutes.
2	Mud	7.3	0.2	
3	Limestone rock	15.3	8.0	

BORING No. 55.

[Located in the Des Plaines River, 2,400 feet west and 700 feet north of the southeast corner of section 11, township 37 north, range 11 east, on the line between Du Page and Cook counties, Ill.]

		Feet.	*Feet.*	
1	Water	7.0	7.0	Elevation of surface of water, 162.3 feet; commenced boring, 9.10 a. m. July 25, 1889; completed boring, 4 p. m. July 25, 1889; depth bored, 28.8 feet; time, 2 hours 45 minutes; depth drilled, 2.2 feet; time, 3 hours 15 minutes.
2	Mud	12.6	5.6	
3	Bowlder	14.8	2.2	
4	Quicksand	31.0	16.2	

BORING No. 56.

[Located in the Des Plaines River, 400 feet south and 600 feet east of the northwest corner of section 14, Township 37 north, range 11 east, on the line between Du Page and Cook counties, Ill.]

		Feet.	*Feet.*	
1	Water	8.5	8.5	Elevation of surface of water, 162.1 feet; commenced boring, 5.15 p. m. July 25, 1889; completed boring, 3.35 p. m., July 26, 1889; depth bored, 29.6 feet; time, 4 hours, 50 minutes; depth drilled, 1.4 feet; time, 1 hour 50 minutes.
2	Mud	13.0	4.5	
3	Bowlder	14.4	1.4	
4	Quicksand	22.0	7.6	
5	Gravel	31.0	9.0	

Borings Along Chicago Route—Continued.

BORING No. 57.

[Located in the Des Plaines River, 1,800 feet south and 1,500 feet west of the northeast corner of section 15, township 37 north, range 11 east, on the line between Du Page and Cook counties, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Water	8.0	8.0	Elevation of surface of water, 162.7 feet; commenced boring, 2.45 p. m. July 30, 1889; completed boring, 5.20 p. m. July 31, 1889; depth bored, 16.1 feet; time, 3 hours 25 minutes; depth drilled, 3 feet; time, 5 hours 55 minutes.
2	Mud	13.0	5.0	
3	Gravel and quicksand	16.1	3.1	
4	Limestone rock	19.1	3.0	

BORING No. 58.

[Located in the Des Plaines River, 1,700 feet east and 2,200 feet north of the southwest corner of section 15, township 37 north, range 11 east, on the line between Du Page and Cook counties, Ill.]

		Feet.	*Feet.*	
1	Water	6.0	6.0	Elevation of surface of water, 162.7 feet; commenced boring 3 p. m. July 30, 1889, completed boring, 5.35 p. m. July 31, 1889; depth bored, 10.5 feet; time, 30 minutes; depth drilled, 3.8 feet; time, 9 hours 40 minutes.
2	Mud	10.5	4.5	
3	Limestone rock	14.3	3.8	

BORING No. 59.

[Located in the Des Plaines River, 1,000 feet north and 500 feet west of the southeast corner of section 16, township 37 north, range 11 east, on the line between Du Page and Cook counties, Ill.]

		Feet.	*Feet.*	
1	Water	11.5	11.5	Elevation of surface of water, 162.5 feet; commenced boring, 1 p. m. August 1, 1889; completed boring, 9.35 a. m. August 2, 1889; depth bored, 22.1 feet; time, 1 hour; depth drilled, 2.3 feet; time, 5 hours.
2	Mud	22.1	10.6	
3	Limestone rock	24.4	2.3	

BORING No. 60.

[Located in the Des Plaines River, 2,600 feet east and 50 feet north of the southwest corner of section 16, township 37 north, range 11 east, on the line between Du Page and Cook counties, Ill.]

		Feet.	*Feet.*	
1	Water	10.4	10.4	Elevation of surface of water, 162.5 feet; commenced boring 1 p. m. August 1, 1889; completed boring 8.35 a. m. August 2, 1889; depth bored, 18.8 feet; time, 30 minutes; depth drilled, 3 feet; time, 5 hours 5 minutes.
2	Mud	18.8	8.4	
3	Limestone rock	21.8	3.0	

Borings Along Sag Route.

(BORING No. 1.)

[Located upon the north bank of Stony Creek, about 740 feet west of the center line of section 32, township 37 north, range 14 east of the third principal meridian,* Calumet Township, county of Cook, in the State of Illinois.]

		Feet.	*Feet.*	
1	Sandy, clay soil	2.8	2.8	Elevation of surface of ground, 154.9 feet; commenced boring, 3 p. m. December 19, 1888; completed boring, 11.35 a. m. December 20, 1888; depth bored, 24 feet; time, 6 hours 20 minutes.
2	Blue clay	11.9	9.1	
3	Fine gravel and quicksand	12.4	0.5	
4	Bluish clay containing small gravel.	23.0	10.6	
5	Gravel	24.0	1.0	

*Note.—All borings described in this report are east of the third principal meridian and that part of the descriptions will be omitted hereafter.

BORINGS ALONG SAG ROUTE—Continued.

BORING No. 2.

[Located on the north bank of Stony Creek, 749 feet west of the section line between sections 31 and 32, township 37 north, range 14 east, township of Calumet, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Bluish clay with small gravel.	11.0	11.0	Elevation of surface of ground, 153.7 feet; commenced boring, 2.20 p. m. December 19, 1888; completed boring, 11.30 a. m. December 21, 1888. Depth bored, 16.8 feet; time, 3 hours, 15 minutes; depth drilled, 2.5 feet; time 12 hours, 25 minutes.
2	Small bowlders driven aside.	12.0	1.0	
3	Clay mixed with coarse gravel.	16.0	4.0	
4	Bluish clay mixed with gravel.	16.8	0.8	
5	Bowlder	19.3	2.5	

BORING No. 3.

[Located 75 feet west of the north and south highway bridge across Stony Creek, upon the north bank of creek, and about 435 feet west of the center line of section 31, township 37 north, range 14 east, township of Calumet, Cook County, Ill.]

		Feet.	*Feet.*	
1	Sandy loam and silt	1.2	1.2	Elevation of surface of ground, 153.5 feet; commenced boring, 3.05 p. m. December 20, 1888; completed boring, 11.30 a. m. December 21, 1888; depth bored, 18.6 feet; time, 2 hours 5 minutes; depth drilled, 1.2 feet; time, 4 hours 25 minutes.
2	Bluish clay with gravel	18.6	17.4	
3	Bowlders	19.8	1.2	

BORING No. 4.

[Located 17 feet west of the north abutment of the Western Avenue Bridge over Stony Creek, at Blue Island, Ill., in section 36, township 37 north, range 14 east.]

		Feet.	*Feet.*	
1	Fine gravel and sand	1.1	1.1	Elevation of surface of ground, 154.5 feet; commenced boring, 3.40 p. m. December 21, 1888; completed boring, 3.45 p. m. December 27, 1888; depth bored, 24.1 feet; time, 16 hours 30 minutes; depth drilled, 1 foot; time, 1 hour 15 minutes.
2	Blue clay and gravel	24.1	23.0	
3	Soft limestone rock in bed	25.1	1.0	

BORING No. 5.

[Located upon the north side of the west abutment of the Vermont Street (One hundred and thirty-first street) Bridge over Stony Creek, 193 feet east of the center line of section 36, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Blue clay with gravel and small bowlders.	18.8	18.8	Elevation of surface of ground, 156.7 feet; commenced boring, 4.45 p. m. December 21, 1888; completed boring, 8.55 a. m. December 28, 1888; depth bored, 20.8 feet; time, 12 hours 5 minutes; depth drilled, 1.2 feet; time, 8 hours 40 minutes.
2	Limestone bowlder	20.0	1.2	
3	Coarse gravel in clay with small bowlders.	22.0	2.0	

BORING No. 6.

[Located on the west bank of Stony Creek, 55 feet south of the center of One hundred and twenty-seventh street (Burr Oak avenue), and 648 feet west of the northeast corner of section 35, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Sandy loam	6.0	6.0	Elevation of surface of ground, 157.7 feet; commenced boring, 9.10 a. m. December 28, 1888; completed boring, 3.20 p. m. December 31, 1888; depth bored, 19.6 feet; time, 6 hours 50 minutes; depth drilled, 3.7 feet; time, 8 hours 30 minutes.
2	Blue clay, free from gravel	10.0	4.0	
3	Fine gravel and sand	13.1	3.1	
4	Blue clay, with small per cent. of gravel.	14.5	1.4	
5	Quicksand	17.0	2.5	
6	Blue clay	18.3	1.3	
7	Bowlders	22.0	3.7	
8	Point driven. No samples obtained.	23.3	1.3	

Borings Along Sag Route—Continued.

BORING No. 7.

[Located on the north bank of creek, 313 feet west of the north and south center line, and 720 feet south of the north line of section 35, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Loam	0.6	0.6	Elevation of surface of ground, 158.5 feet; commenced boring 10 54 a. m. December 28, 1888; completed boring, 4 p. m. December 31, 1888; depth bored, 10.5 feet; time, 36 minutes; depth drilled, 5.5 feet; time, 15 hours 40 minutes.
2	Clay, free from gravel and soft.	10.5	9.9	
3	Limestone rock	16.0	5.5	

BORING No. 8.

[Located on the north bank of creek and on the north and south center line of section 35, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

Elevation of surface of ground, 158.5 feet; this boring was made with a 2-inch auger which was "twisted" to the depth of 11.7 feet, to rock, which was tested with drill; time, 7 minutes (boring); material same as in Boring No. 7.

BORING No. 9.

[Located 400 feet east and 1,600 feet south of the northwest corner of section 36, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	2.0	2.0	Elevation of surface of ground, 157.5 feet; commenced boring, 10.45 a. m. January 1, 1889; completed boring, 8.05 a. m. January 3, 1889; depth bored, 9.2 feet; time, 2 hours 35 minutes; depth drilled, 5.1 feet; time, 11 hours 15 minutes.
2	Blue clay free from gravel	9.2	7.2	
3	Limestone rock	14.3	5.1	

BORING No. 10.

[Located upon the south bank of Stony Creek, 16 feet west of the center line of section 26, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Bluish clay	9.0	9.0	Elevation of surface of ground, 158.2 feet; commenced boring, 8.15 a. m. January 1, 1889; completed boring, 11 a. m. January 7, 1889; depth bored, 17.2 feet; time, 7 hours 30 minutes; depth drilled, 5.2 feet; time, 29 hours 50 minutes.
2	Fine gravel	11.0	2.0	
3	Quicksand	12.0	1.0	
4	Blue clay	17.2	5.2	
5	Very hard slate-colored limestone rock, with seams or layers of soft shale.	22.4	5.2	

BORING No. 11.

[Located on the section line between sections 35 and 34, township 37 north, range 13 east, and 678 feet from the northwest corner of section 35, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	0.8	0.8	Elevation of surface of ground, 162.7; commenced boring, 9.55 a. m. January 3, 1889; completed boring, 2.42 p. m. January 7, 1889; depth bored 11.8 feet time, 9 hours 25 minutes; depth drilled, 5.2 feet; time, 18 hours 7 minutes.
2	Blue clay with coarse gravel	11.8	11.0	
3	Rock in layers with thin seams of shale.	17.0	5.2	

BORING No. 12.

[Located 6 feet north of the bank of the creek, 12 feet east of the north and south center line, and 1,090 feet south of the north line of section 34, township 37 north; range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	1.0	1.0	Elevation of surface of ground, 163.7 feet; commenced boring, 1.35 p. m. January 7, 1889; completed boring 9 a. m. January 11, 1889; depth bored, 8 feet; time, 3 hours 25 minutes; depth drilled, 5.7 feet; time, 14 hours 25 minutes.
2	Clay and gravel	8.0	7.0	
3	Soft limestone rock in layers	13.7	5.7	

Borings Along Sag Route—Continued.

BORING No. 13.

[Located 33 feet west of the east line, and 957 feet south of the north line of section 33, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Loam	2.0	2.0	Elevation of surface of ground, 164.3 feet; commenced boring, 4.05 p. m. January 7, 1889; completed boring, 9.15 a. m. January 11, 1889; depth bored, 11.8 feet; time, 4 hours 55 minutes; depth drilled. 5.4 feet; time, 11 hours.
2	Yellow sandy clay	8.0	6.0	
3	Blue clay	11.8	3.8	
4	Limestone rock	17.2	5.4	

BORING No. 14.

[Located 19 feet east of the center line of the northeast quarter of section 34, township 37 north, range 13 east, on the north bank of the creek, Worth Township, Cook County, Ill.]

Elevation of surface of ground, 162.3 feet; commenced boring, 10 a. m. January 11, 1889; completed boring, 10.50 a. m. January 11, 1889.

This boring was put down with a 2-inch well auger to determine the depth to the rock. Material penetrated is blue clay; drill test was made upon rock, which was reached at depth of 9.1 feet.

BORING No. 15.

[Located 46 feet north and 51 feet east of the center of the south line of section 28, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	5.0	5.0	Elevation of surface of ground, 165.8 feet; commenced boring, 10.35 a. m. January 11, 1889; completed boring, 11.42 a. m. January 12, 1889; depth bored, 33.9 feet; time 7 hours 17 minutes; depth drilled, 1.6 feet; time, 2 hours 50 minutes.
2	Blue clay, soft	17.6	12.6	
3	Blue clay, hard	33.9	16.3	
4	Soft limestone rock	35.5	1.6	

BORING No. 16 A.

[Located 5 feet west of the east line and 1,707 feet north of the south line of section 29, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Peat	3.3	3.3	Elevation of surface of ground, 165.5 feet; Commenced boring, 2.5 p. m. January 11, 1889; abandoned boring, 4.50 p. m. January 14, 1889; depth bored, 22.5 feet; time, 6 hours 40 minutes; depth drilled, 3.5 feet; time, 11 hours 50 minutes.
2	Clay	14.1	10.8	
3	Bowlder	16.3	2.2	
4	Clay	20.6	4.3	
5	Bowlder	21.9	1.3	
6	Clay	26.0	4.1	

BORING No. 16.

[Located 1,673 feet north and 5 feet west of the southeast corner of section 29, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Blue clay	16.6	16.6	Elevation of surface of ground, 165.6 feet; commenced boring, 7.35 a. m. Jan. 15, 1889; completed boring, 3.47 p. m. Jan. 18, 1889; depth bored, 17.7 feet; time, 4 hours 40 minutes; depth drilled, 9.6 feet; time, 23 hours 27 minutes.
2	Soft limestone in layers	21.2	4.6	
3	Blue clay	22.3	1.1	
4	Hard limestone rock	27.3	5.0	

BORING No. 17.

[Located 233 feet north and 15 feet west of the center of the east line of section 27, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	0.8	0.8	Elevation of surface of ground, 158.3 feet; commenced boring, 9.55 a. m. January 15, 1889; completed boring, 10.10 a. m. January 16, 1889; depth bored, 24.8 feet; time, 5 hours 25 minutes; depth drilled, .8 foot; time 1 hour 30 minutes.
2	Yellow sandy clay, wet and soft.	3.4	2.6	
3	Hard, dry, blue clay	23.8	20.4	
4	Limestone bowlder	24.6	0.8	
5	Hard, blue clay	25.6	1.0	

BORINGS ALONG SAG ROUTE—Continued.

BORING No. 18.

[Located 900 feet north and 60 feet east of the center of section 27, township 37 north, range 13 east, Worth Township, Cook Co., Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Loam	3.5	3.5	Elevation of surface of ground, 159.5 feet; commenced boring, 1.55 p. m. January 16, 1889; completed boring, 4.50 p. m. January 18, 1889; depth bored, 15 3 feet; time, 1 hour 55 minutes; depth drilled 6.7 feet; time, 17 hours 40 minutes.
2	Blue clay	15.3	11.8	
3	Hard limestone rock	22.0	6.7	

BORING No. 19.

[Located 600 feet south and 300 feet east of the center of section 26, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	0.9	0.9	Elevation of surface of ground, 158.9 feet; commenced boring, 8.05 a. m. January 19, 1889; completed boring, 4.28 p. m. January 24, 1889; depth bored, 15 feet; time, 5 hours; depth drilled, 7.6 feet; time, 28 hours 55 minutes.
2	Blue clay	7.4	6.5	
3	Gravel	8.9	1.5	
4	Blue clay	15.0	6.1	
5	Limestone rock	22.6	7.6	

BORING No. 20.

[Located 81 feet north and 244 feet west of the southeast corner of section 22, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	1.2	1.2	Elevation of surface of ground, 160.1 feet; commenced boring, 10.35 a. m. January 19, 1889; completed boring, 11.25 a. m. January 23, 1889; depth bored, 25.8 feet; time, 12 hours 33 minutes; depth drilled, 1.7 feet; time, 5 hours 15 minutes.
2	Yellow clay	3.2	2.0	
3	Blue clay	17.9	14.7	
4	Gravel	19.5	1.6	
5	Quicksand	23.8	4.3	
6	Bowlders	25.5	1.7	
7	Coarse gravel	27.5	2.0	

BORING No. 21.

[Located 25 feet south of the east and west center line and 2,000 feet west of the east line of section 22, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Split and broken limestone in yellow clay.	4.5	4.5	Elevation of surface of ground, 162.5 feet; commenced boring, 4.25 p. m. January 23, 1889; completed boring, 4.30 p. m. February 4, 1889. depth bored, 6 4 feet; time, 13 hours 55 minutes; depth drilled, 23.1 feet; time, 32 hours 43 minutes.
2	Soft limestone bowlder	5.4	0.9	
3	Limestone bowlders in yellow clay.	7.3	1.9	
4	Limestone bowlders	29.5	22.2	

BORING No. 22.

[Located 952 feet east and 500 feet south of the center of section 26, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Blue clay with bowlders	12.9	12.9	Elevation of surface of ground, 162.3 feet; commenced boring, 7 a. m. January 25, 1889; completed boring, 5.20 p. m. January 28, 1889; depth bored, 12.9 feet; time, 8 hours 45 minutes; depth drilled, 4.9 feet; time, 11 hours 20 minutes.
2	Limestone rock	17.8	4.9	

Boring Along Sag Route—Continued.

BORING No. 23 A.

[Located on east bank of Stony Creek, 720 feet north of the south line of section 22, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Loam	0.6	0.6	Elevation of surface of ground, 161 feet; commenced boring, 10.5 a. m. January 29, 1889; abandoned boring, 5.20 p. m. February 5, 1889; depth bored, 19.6 feet; time, 11 hours 5 minutes; depth drilled, 3.8 feet; time, 14 hours 40 minutes.
2	Yellow clay	2.6	2.0	
3	Blue clay	9.3	6.7	
4	Fine gravel	9.8	0.5	
5	Soft limestone bowlder	11.0	1.2	
6	Hard, dry, blue clay	12.7	1.7	
7	Soft limestone bowlder	13.9	1.2	
8	Blue clay	22.0	8.1	
9	Limestone rock; boring abandoned.	23.4	1.4	

BORING No. 23.

[Located on ice of Stony Creek, 720 feet north of south line of section 22, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Water; Stony Creek	4.3	4.3	Elevation of surface of ice, 159 feet; commenced boring, 8.30 a. m., February 7, 1889; completed boring, 5 30 p. m.; February 8, 1889; depth bored, 20.2 feet; time, 1 hour 10 minutes; depth drilled, 2.4 feet; time, 8 hours 35 minutes.
2	Quicksand	18.5	14.2	
3	Fine gravel	20.2	1.7	
4	Limestone rock, hard	22.6	2.4	

BORING No. 24.

[Located 398 feet north and 11 feet east of the west quarter corner of section 22, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Brown, sandy loam	2.9	2.9	Elevation of surface of ground, 160.6 feet; commenced boring, 11.15 a. m. February 6, 1889; completed boring, 5.15 p. m. February 13, 1889; depth bored, 2.9 feet; time, 15 minutes; depth drilled, 20.7 feet; time, 41 hours 46 minutes.
2	Limestone and granite bowlders with sand and gravel between.	23.6	20.7	

BORING No. 25.

[Located 2,300 feet south and 400 feet west of the northeast corner of section 29, township 37, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Decayed vegetable matter	1.3	1.3	Elevation of surface of ground, 165.4 feet; commenced boring, 2.28 p.m. February 4, 1889; completed boring, 4.45 p. m. February 5, 1889; depth bored 33.5 feet; time, 11 hours 27 minutes.
2	Blue and yellow clay	2.5	1.2	
3	Blue clay	20.0	17.5	
4	Fine gravel	33.5	13.5	

BORING No. 26.

[Located 1,400 feet east and 1,200 feet south of the northwest corner of section 29, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Blue and yellow clay	8.0	7.2	Elevation of surface of ground, 165 feet; commenced boring, 7.30 a. m. February 6, 1889, completed boring, 4 p. m. February 6, 1889; depth bored, 31.5 feet; time, 6 hours 45 minutes.
2	Blue clay with sand	11.0	3.0	
3	Blue clay with vegetable matter.	19.0	8.0	
4	Blue clay with shells	22.5	3.5	
5	Fine gravel	23.5	1.0	
6	Blue clay with gravel and stones, dry.	31.5	8.0	

Boring Along Sag Route—Continued.

BORING No. 27.

[Located 1,600 feet west and 700 feet north of the southwest corner of section 19, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Water	1.5	1.5	Elevation of surface of ice, 165 feet; commenced boring, 7.15 a. m. February 7, 1889; completed boring, 9.41 a. m. February 9, 1889; depth bored, 29.6 feet; time, 5 hours 6 minutes; depth drilled, 1.9 feet; time, 12 hours 26 minutes.
2	Silt	2.0	0.5	
3	Peat	11.0	9.0	
4	Dry loam mixed with shells	16.0	5.0	
5	Fine gravel with sand	23.0	7.0	
6	Dry, blue clay	24.0	1.0	
7	Limestone bowlder	25.9	1.9	
8	Gravel	31.5	5.6	

BORING No. 28.

[Located 300 feet west and 1,400 feet north of the southeast corner of section 24, township 37 north, range 12 east. Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Water	1.5	1.5	Elevation of surface of ice, 164.9 feet; commenced boring, 2.20 p. m. February 9, 1889; completed boring 9.18, a. m. February 11, 1889; depth bored 32 feet; time, 5 hours, 16 minutes.
2	Peat	6.0	4.5	
3	Blue clay	10.0	4.0	
4	Peat	21.7	11.7	
5	Fine gravel	22.2	.5	
6	Blue clay with sand	29.5	7.3	
7	Coarse gravel	32.0	2.5	

BORING No. 29.

[Located 1,800 feet east and 1,700 feet north of the southwest corner of section 24, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	1.0	1.0	Elevation of surface of ground, 163.1 feet; commenced boring, 11.20 a. m. February 11, 1889, completed boring, 5.20 p. m. February 11, 1889; depth bored, 32 feet; time, 5 hours 45 minutes.
2	Peat	8.0	7.0	
3	Blue and yellow clay	14.5	6.5	
4	Peat	18.9	4.4	
5	Pure blue clay	21.5	2.6	
6	Blue clay with stones	26.0	4.5	
7	Pure blue clay	32.0	6.0	

BORING No. 30.

[Located 714 feet west and 444 feet north of the east quarter corner of section 23, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	1.5	1.5	Elevation of surface of ground, 163.3 feet; commenced boring 8 a. m. February 13, 1889; completed boring 3.26 p. m. Febraury 14, 1889; depth bored, 28.8 feet; time, 10 hours 25 minutes; depth drilled, 1.4 feet; time, 4 hours 6 minutes.
2	Yellow clay	8.0	6.5	
3	Dry blue clay	14.6	6.0	
4	Coarse gravel	17.0	3.0	
5	Blue clay with sand	18.5	1.5	
6	Gravel with large stones	28.8	10.3	
7	Limestone bowlders	30.2	1.4	

BORING No. 31 A.

[Located on the north and south center line and 1,600 feet south of the north line of section 23, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Ice	0.4	0.4	Elevation of surface of ice, 162.4 feet; commenced boring, 4.45 p.m. February 14, 1889; abandoned boring, 4.15 p. m. February 16, 1889; depth bored, 22 feet; time, 15 hours 30 minutes; depth drilled, .7 feet; time, 1 hour.
2	Black soil and vegetable matter.	4.5	4.1	
3	Blue clay	6.5	2.0	
4	Peat	11.0	4.5	
5	Blue clay with stones	22.0	11.0	
6	Limestone rock	22.7	0.7	

Borings Along Sag Route—Continued.

BORING No. 31.

[Located 120 feet west of the north and south center line and 1,600 feet south of the north line of section 23, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Loam	3.0	3.0	Elevation of surface of ground, 162.4 feet; commenced boring, 2.30 p. m. February 19, 1889; completed boring, 3.20 p. m. March 6, 1889; depth bored, 16.2 feet; time, 12 hours, 15 minutes; depth drilled, 12.4 feet; time, 38 hours 35 minutes.
2	Clay and gravel	16.9	13.9	
3	Limestone rock	28.6	11.7	

BORING No. 32.

[Located on the south bank of the feeder, 326 feet east of the north and south section line between sections 22 and 23, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	2.5	2.5	Elevation of surface of ground, 162.4 feet; commenced boring, 2.45 p. m. March 7, 1889; completed boring, 12.30 p. m. March 12, 1889; depth bored, 25.2 feet; time, 11 hours, 25 minutes; depth drilled, 0.7 feet; time, 2 hours 25 minutes.
2	Sand	12.5	10.0	
3	Peat	13.5	1.0	
4	Gravel	15.9	2.4	
5	Clay, sand, and gravel	20.0	4.1	
6	Quicksand	25.2	5.2	
7	Limestone rock	25.9	0.7	

BORING No. 33.

[Located 136 feet east and 36 feet north of the southwest corner of section 15, township 37 north, range 13 east, Worth Township, Cook County, Ill.

		Feet.	*Feet.*	
1	Sandy clay	2.8	2.8	Elevation of surface of ground, 160.6 feet; commenced boring, 2.20 p. m. February 14, 1889; completed boring, 4.40 p. m. February 21, 1889; depth bored, 2.8 feet; time, 25 minutes; depth drilled, 23.8 feet; time, 55 hours 57 minutes.
2	Limestone and granite bowlders imbedded in blue clay and gravel.	26.6	23.8	

BORING No. 34.

[Located 773 feet south and 43 feet east of the center of section 16, township 37 north, 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Clay	2.9	2.9	Elevation of surface of ground, 162 feet; commenced boring, 11.15 a. m. February 22, 1889; completed boring, 4.10 p. m. February 25, 1889; depth bored, 13.2 feet; time, 5 hours 50 minutes; depth drilled, 14.8 feet; time, 11 hours 13 minutes.
2	Limestone bowlders	8.5	5.6	
3	Hard, blue clay	12.5	4.0	
4	Quicksand	14.3	1.8	
5	Limestone bowlders	23.5	9.2	
6	Blue clay	28.0	4.5	

BORING NO. 35.

Located 60 feet east and 872 feet south of the northwest corner of section 16, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	3.5	3.5	Elevation of surface of ground, 161.5 feet; commenced boring 10.30 p. m. February 26, 1889; completed boring 2.55 p. m. March 6, 1889; depth bored, 9.4 feet; time, 2 hours and 30 minutes; depth drilled, 18.8 feet; time, 43 hours 54 minutes.
2	Soft muck	6.0	2.5	
3	Vegetable matter	7.3	1.3	
4	Hard, dry, blue clay	9.4	2.1	
5	Limestone bowlders and gravel.	28.2	18.8	

Borings Along Sag Route—Continued.

BORING No. 36.

[Located 36 feet east and 1,080 feet north of the southwest corner of section 8, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Loam	3.0	3.0	Elevation of surface of ground, 162.1 feet; commenced boring, 11 a. m. March 7, 1889; completed boring, 5.13 p. m. March 8, 1889; depth bored, 22.1 feet; time, 6 hours, 8 minutes; depth drilled, 6.2 feet; time, 5 hours 15 minutes.
2	Blue clay with sand	10.0	7.0	
3	Limestone bowlders with gravel.	19.4	9.4	
4	Fine sand and gravel	28.3	8.9	

BORING No. 37.

[Located 40 feet east and 1,600 feet south of the northwest corner of section 18, township 37 north, range 13 east, Worth Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	2.0	2.0	Elevation of surface of ground, 162.3 feet; commenced boring, 1 p. m. March 11, 1889; completed boring, 5.10 p. m. March 11, 1889; depth bored, 29.5 feet; time, 4 hours 10 minutes.
2	Blue clay with sand	9.0	7.0	
3	Quicksand	11 0	2.0	
4	Blue clay with gravel	15.0	4.0	
5	Quicksand	19.0	4.0	
6	Blue clay with gravel	27.0	8.0	
7	Fine gravel	29.5	2.5	

BOARING No. 38.

[Located on the north bank of the feeder, 28 feet east of the west line of section 13, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	2.0	2.0	Elevation of surface of ground, 163.4 feet: commenced boring, 3 p. m. March 12, 1889; completed boring, 12 m. March 13, 1889; depth bored, 23.8 feet; time, 2 hours 15 minutes; depth drilled, 6 feet; time, 4 hours 45 minutes.
2	Blue clay	12.0	10.0	
3	Peat	20.0	8.0	
4	Limestone bowlders	26.0	6.0	
5	Fine gravel	29.8	3.8	

BORING No. 39.

[Located 199 feet west of the north and south center line and 2,230 feet south of the north line of section 23, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	2.5	2.5	Elevation of surface of ground, 163 feet; commenced boring, 3.45 p. m. March 12, 1889; completed boring, 5.15 p. m. March 15, 1889; depth bored, 21 feet; time, 12 hours 25 minutes; depth drilled, 5.5 feet; time, 16 hours 30 minutes.
2	Blue clay	6.5	4.0	
3	Quicksand	14.3	7.8	
4	Blue clay with gravel	21.0	6.7	
5	Limestone rock	26.5	5.5	

BORING No. 40.

[Located 1,326 feet south of the north line and 2,300 feet west of the east line of section 22, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Black soil	2.0	2.0	Elevation of surface of ground, 162.2 feet; commenced boring, 2.20 p. m. March 14, 1889; completed boring, 3 p. m. March 16, 1889; depth bored, 15.5 feet; time, 55 minutes; depth drilled, 10.5 feet; time, 15 hours 12 minutes.
2	Clay and gravel	15.5	13.5	
3	Bowlders	26.0	10.5	

BORINGS ALONG SAG ROUTE—Continued.

BORING No. 41.

[Located on south side of highway, 30 feet from the feeder, 80 feet east and 1,310 feet south of the northwest corner of section 22, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Sandy clay of waste bank. ..	2.0	2.0	Elevation of surface of ground, 165.2 feet; commenced boring, 1.20 p. m. March 18, 1889; completed boring, 6.30 p. m. March 20, 1889; depth bored, 12 feet; time, 40 minutes; depth drilled, 19.9 feet; time, 20 hours 10 minutes.
2	Black loam, surface soil	5.0	3.0	
3	Blue clay	9.8	4.8	
4	Bowlders	18.2	8.4	
5	Peat	20.4	2.2	
6	Bowlders	31.9	11.5	

BORING No. 42.

[Located on the west side of highway, 42 feet from the center of same, 116 feet south of the north line of section 22, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Black soil	1.5	1.5	Elevation of surface of ground, 165.1 feet; commenced boring, 12.52 p. m. March 21, 1889; completed boring, 5.15 p. m. March 21, 1889; depth bored, 37 feet; time, 4 hours 23 minutes.
2	Sand.....	3.7	2.2	
3	Blue clay	12.0	8.3	
4	Blue clay and shells	18.0	6.0	
5	Peat.....	37.0	19.0	

BORING No. 43.

[Located 50 feet south of the feeder, 1,047 feet south and 45 feet west of the north quarter corner of section 21, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Peat.....	4.2	4.2	Elevation of surface of ground, 164.1 feet; commenced boring, 2.30 p. m. March 22, 1889; completed boring, 10.40 a. m. March 26, 1889; depth bored, 8.8 feet; time, 35 minutes; depth drilled, 17.2 feet; time, 22 hours 15 minutes.
2	Blue clay.....	8.8	4.6	
3	Bowlders.....	13.3	4.5	
4	Limestone rock.....	26.0	12.7	

BORING No. 44.

[Located 87 feet west and 528 feet south of the northeast corner of section 20, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Peat.....	15.7	15.7	Elevation of surface of ground, 168 feet; commenced boring, 7.58 a. m. March 27, 1889; completed boring, 9.30 a. m. March 29, 1889; depth bored, 31.1 feet; time, 17 hours 50 minutes; depth drilled, 5.3 feet; time, 3 hours 18 minutes.
2	Gravel	17.2	1.5	
3	Bowlders	22.5	5.3	
4	Gravel	36.4	13.9	

BORING No. 45.

[Located 700 feet north and 400 feet east of the south quarter corner of section 17, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Muck and peat	9.1	9.1	Elevation of surface of ground, 163.9 feet; commenced boring, 5 p. m. March 18, 1889; completed boring, 5.25 p. m. March 21, 1889; depth bored, 13.1 feet; time, 2 hours 55 minutes; depth drilled, 9.1 feet; time, 21 hours.
2	Gravel	13.1	4.0	
3	Bowlders	18.2	5.1	
4	Limestone rock.....	22.2	4.0	

Borings Along Sag Route—Continued.

BORING No. 46.

[Located 300 feet east of the north and south center line, and 1,600 feet north of the south line of section 17, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Peat	14.0	14.0	Elevation of surface of ground, 168.9 feet; commenced boring 9 a. m. March 22, 1889; completed boring, 10.40 a. m. March 26, 1889; depth bored, 19.6 feet; time, 5 hours; depth drilled, 10.2 feet; time, 20 hours, 1 minute.
2	Clay	16.0	2.0	
3	Gravel	19.6	3.6	
4	Bowlder	20.3	0.7	
5	Limestone rock	29.8	9.5	

BORING No. 47.

[Located 15 feet west and 300 feet south of the northeast corner of section 21, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	1.3	1.3	Elevation of surface of ground, 165.4 feet; commenced boring, 2.10 p. m. March 26, 1889; completed boring, 6 p. m. March 28, 1889; depth bored, 30.1 feet; time, 18 hours 40 minutes; depth drilled, 7 feet; time, 3 hours 42 minutes.
2	Blue clay with sand	10.0	8.7	
3	Sand, gravel, and bowlders	19.0	9.0	
4	Quicksand	30.1	11.1	
5	Boulder	30.8	0.7	

BORING No. 48.

[Located 132 feet north and 29 feet east of the south quarter corner of section 16, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	3.0	3.0	Elevation of surface of ground, 169.1 feet; commenced boring, 1.30 p. m. March 29, 1889; completed boring, 11.15 a. m. March 30, 1889; depth bored, 35.5 feet; time, 8 hours 30 minutes.
2	Peat	11.5	8.5	
3	Clay	18.5	7.0	
4	Sand	22.0	3.5	
5	Quicksand	35.5	13.5	

BORING No. 49.

[Located on north and south highway, 412 feet north, and 5 feet east of the southwest corner of section 16, township 37 north; range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Peat	19.4	19.4	Elevation of surface of ground, 167.6 feet; commenced boring, 9.40 a. m. March 28, 1889; completed boring, 5.35 p. m. March 29, 1889; depth bored, 34.6 feet; time, 10 hours 19 minutes; depth drilled, 1.2 feet; time, 6 hours 26 minutes.
2	Gravel	20.2	0.8	
3	Bowlder	21.4	1.2	
4	Blue clay	26.8	5.4	
5	Hard, dry quicksand	35.8	9.0	

BORING No. 50.

[Located 100 feet south and 100 feet west of the center of section 17, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	7.0	7.0	Elevation of surface of ground, 166.6 feet; commenced boring, 10.40 a. m. March 29, 1889; completed boring, 5.10 p. m. April 1, 1889; depth bored, 34 feet; time, 11 hours 58 minutes.
2	Peat	22.1	15.1	
3	Blue clay with gravel	34.0	11.9	

BORINGS ALONG SAG ROUTE—Continued.

BORING No. 51.

[Located 100 feet east and 1,600 feet north of the southwest corner of section 17, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Loam	1.3	1.3	Elevation of surface of ground, 160.8 feet; commenced boring, 11.40 a. m. March 29, 1889; completed boring, 5 p. m. April 1, 1889; depth bored, 22.5 feet; time, 4 hours 22 minutes; depth drilled 2.4 feet; time 6 hours 45 minutes.
2	Yellow clay	6.5	5.2	
3	Quicksand	11.0	4.5	
4	Gravel with shells	12.5	1.5	
5	Hard, dry, blue clay	22.0	9.5	
6	Gravel	22.5	0.5	
7	Limestone rock	24.9	2.4	

BORING No. 52.

[Located 100 feet east and 2,300 feet north of the southwest corner of section 17, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Loam	2.5	2.5	Elevation of surface of ground, 160.9 feet; commenced boring, 2.40 p. m. March 29, 1889; completed boring, 11.00 a. m. April 3, 1889; depth bored, 19.5 feet; time, 7 hours 15 minutes; depth drilled, 3.7 feet; time, 12 hours 10 minutes
2	Blue clay	8.7	6.2	
3	Quicksand	9.9	1.2	
4	Gravel	13.0	3.1	
5	Quicksand	16.5	3.5	
6	Gravel	19.5	3.0	
7	Limestone rock	23.2	3.7	

BORING No. 53.

[Located 2,200 feet north and 1,700 feet west of the southeast corner of section 18, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Black dirt	3.0	3.0	Elevation of surface of ground, 160.8 feet; commenced boring, 4.10 p. m. April 2, 1889; completed boring, 4.45 p. m. April 2, 1889; depth bored, 16.5 feet; time, 35 minutes.
2	Peat	16.0	13.0	
3	Gravel overlying limestone rock.	16.5	0.5	

BORING No. 54.

[Located 2,900 feet north and 1,900 feet west of the southeast corner of section 18, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Black dirt	6.0	6.0	Elevation of surface of ground, 162.4 feet; commence boring, 8.30 a. m. April 3, 1889; completed boring, 12.10 p. m. April 3, 1889; depth bored, 15.9 feet; time, 3 hours 40 minutes.
2	Gravel	7.0	1.0	
3	Blue clay	13.5	6.5	
4	Gravel overlying limestone rock.	15.9	2.4	

BORING No. 55.

[Located 2,400 feet north and 2,000 feet east of the southwest corner of section 18, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

		Feet.	*Feet.*	
1	Black dirt	2.5	2.5	Elevation of surface of ground, 161.4 feet; commenced boring 12.50 p. m., April 3, 1889; completed boring, 1.35 p. m., April 3, 1889; depth bored, 9.9 feet; time, 45 minutes.
2	Yellow clay	6.5	4.0	
3	Quicksand overlying limestone rock.	9.9	3.4	

Borings Along Sag Route—Continued.

BORING No. 56.

[Located 1,800 feet north and 1,200 feet east of the southwest corner of section 18, township 37 north, range 12 east, Palos Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	Elevation of surface of ground, 160.5 feet; commenced boring, 2.35 p. m. April 3, 1889; depth bored, 5.5 feet. Four tests were made at this place to solid rock. The first was 4.8 feet in depth. The second, 22 feet east, was 5.3 feet in depth. The third, 30 feet north, was 5.5 feet in depth. The fourth, 40 feet west, was 5 feet in depth. All penetrations were through 1 foot of black loam, then blue clay to a thin layer of gravel overlying the limestone rock.
1	Loam	1.0	1.0	
2	Blue clay	5.5	4.5	
3	Thin layer of gravel			

BORING No. 57.

[Located 390 feet west and 2,700 feet north of the southeast corner of section 13, township 37 north, range 11 east, Lemont Township, Cook County, Ill.]

		Feet.	*Feet.*	Elevation of surface of ground, 162 feet; commenced boring, 4.45 p. m. April 2, 1889; completed boring, 11.30 a. m. April 3, 1889; depth bored, 2.5 feet; time, 20 minutes; depth drilled, 5.1 feet; time 4 hours 25 minutes.
1	Loam	0.9	0.9	
2	Yellow sand	2.5	1.6	
3	Limestone chips and slabs	2.9	0.4	
4	Solid rock	7.6	4.7	

BORING No. 58.

[Located 2,324 feet west and 2,900 feet north of the southeast corner of section 13, township 37 north, range 11 east, Lemont Township, Cook County, Ill.]

		Feet.	*Feet.*	Elevation of surface of ground, 166.8 feet; commenced boring, 8.00 a. m.; April 4, 1889; completed boring, 9.15 a. m.; April 4, 1889; depth bored, 12.9 feet; time, 1 hour, 15 minutes.
1	Black dirt	8.0	8.0	
2	Clay, gravel, and sand	12.9	4.9	

BORING No. 59.

[Located 1,897 feet east of the west line and 2,200 feet south of the north line of section 13, township 37 north, range 11 east, Lemont Township, Cook County, Ill.]

		Feet.	*Feet.*	Elevation of surface of ground, 159.7 feet; commenced boring, 9.30 a. m. April 4, 1889; completed boring, 10.15 a. m. April 4, 1889; depth bored, 4 feet; time, 45 minutes.
1	Black dirt	2.5	2.5	
2	Quicksand overlying limestone rock.	4.0	1.5	

BORING No. 60.

[Located 1,700 feet south and 800 feet east of the northwest corner of section 13, township 37 north, range 11 east, Lemont Township, Cook County, Ill.]

		Feet	*Feet.*	
1	Black dirt	1.5	1.5	Elevation of surface of ground, 161.8 feet; commenced boring, 10.30 a. m., April 4, 1889; completed boring, 1.30 p. m. April 4, 1889; depth bored, 17 feet; time, 3 hours.
2	Blue clay	3.0	1.5	
3	Gravel	5.5	2.5	
4	Decayed vegetable matter	8.5	3.0	
5	Blue clay	14.0	5.5	
6	Gravel overlying limestone rock.	17.0	3.0	

BORINGS ALONG SAG ROUTE—Continued.

BORING No. 61.

[Located 500 feet north of the feeder, 1,500 feet south and 1,400 feet west of the northeast corner of section 14, township 37 north, range 11 east, Lemont Township, Cook County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Sod	0.5	0.5	Elevation of surface of ground, 164.2 feet; commenced boring, 9 a. m. April 4th, 1889; completed boring, 5.15 p. m. April 5th, 1889; depth bored, 7 feet; time, 1 hour 30 minutes; depth drilled, 16.4 feet; time, 14 hours 45 minutes.
2	Bowlders	11.8	11.3	
3	Clay	18.3	6.5	
4	Limestone rock	23.4	5.1	

Tests for depths to rock from the surface, in section 13, township 37 north, range 11 east, Lemont Township, Cook County, Ill.: In feeder at township line, 3.2 feet below water; 150 feet north of feeder, at township line, 2.5 feet below ground; 400 feet north of feeder, at township line, 3.6 feet below ground; 400 feet west of township line, 150 feet south of Boring No. 57, 3.6 feet below ground; 400 feet west of township line, 500 feet north of feeder, 6.1 feet below ground: 660 feet west of township line, at feeder, 2. feet below water; 1,320 feet west of township line, at feeder, 3 feet below water; 1,320 feet west of township line, 200 feet north of feeder, 7 feet below ground; 1,120 feet west of township line, 600 feet north of feeder, 5.7 feet below ground; 1,980 feet west of township line, in feeder, 3 feet below water; 2,640 feet west of township line, at quarter section line, in feeder, 2.3 feet below water; 300 feet west of quarter section line, in feeder, a ridge of solid rock rises to top of feeder bank; 350 feet west of quarter section line, 300 feet north of feeder, 5.8 feet below ground; 700 feet west of quarter section line, in feeder, 4.3 feet below water; elevation of water-surface in feeder, 157.1 feet; elevation of surface of ground varies at points mentioned from 160 to 162 feet.

A test was also made 1,700 feet north and 2,700 feet east of the southwest corner of section 18, township 37 north, range 12 east, Palos Township, Cook County, Ill., and rock was struck at 7.2 feet below water in ditch. Elevation of water in ditch, 159.8 feet.

A test was also made at a well, 50 feet east and 1,600 feet south of the northeast corner of section 14., township 37 north, range 11 east, Lemont Township, Cook County, Ills., and rock was struck at a depth of 13 feet. Elevation of curb of well 165.2 feet.

BORINGS IN ILLINOIS RIVER ABOVE MARSEILLES.

BORING No. 1.

[Located 1,800 feet west of the east line of section 26, township 34 north, range 8 east, in the Illinois River, 260 feet from the south bank and 1,350 feet above the head of a large island opposite Dresden, Ill., and 1 mile below the mouth of the Kankakee River.]

No.		Depth.	Thickness.	Ramarks.
		Feet.	*Feet.*	
1	Water	5.1	5.1	Elevation of surface of water, 55.6 feet; commenced boring, 8.15 a. m. August 7, 1889; completed boring, 2.15 p. m. August 8, 1889; depth, bored, 6.8 feet; time, 40 minutes; depth, drilled, 3.2 feet; time, 13 hours.
2	Gravel	6.8	1.7	
3	Sandstone bowlder	7.7	0.9	
4	Limestone rock	10.0	2.3	

BORING No. 2.

[Located 900 feet east of the west line of section 26, township 34 north, range 8 east, in the Illinois River, 180 feet from the south bank, and 1,210 feet below the head of large island opposite Dresden, Ill.]

		Feet.	*Feet*	
1	Water	8.0	8.0	Elevation of surface water, 55.6 feet; commenced boring 8 a. m. August 7, 1889; completed boring, 4.30 p. m. August 7, 1889; depth bored, 15.7 feet; time, 6 hours 30 minutes; depth drilled, 1 foot; time, 1 hour.
2	Gravel	10.5	2.5	
3	Sandstone bowlder	11.5	1.0	
4	Gravel	16.7	5.2	

Borings in Illinois River above Marseilles—Continued.

BORING No. 3.

[Located 1,900 feet west of the east line of section 27, township 34 north, range 8 east. In the Illinois River, 75 feet from the north bank and 1,110 feet below the foot of lower island, opposite Dresden, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Water	5.4	5.4	Elevation of surface of water, 55.6 feet; commenced boring, 5.10 p. m. August 7, 1889; completed boring, 9.30 a. m. August 8, 1889; depth bored, 17 feet; time, 2 hours 35 minutes.
2	Sand and gravel	17.0	11.6	

BORING No. 4.

[Located in the Illinois River, 200 feet from the north bank, and opposite a small island in the southwest quarter of section 27, township 34 north, range 8 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	3.6	3.6	Elevation of surface of water, 55.5 feet; commenced boring, 11 a. m. August 8, 1889; completed boring, 4.40 p. m. August 8, 1889; depth bored, 16.7 feet, time, 4 hours 40 minutes.
2	Sand and gravel	16.7	13.1	

BORING No. 5.

[Located in the Illinois River, 430 feet from the south bank and just at the bend in the river in the southeast quarter of section 28, township 34 north, range 8 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	3.7	3.7	Elevation of surface of water, 56.2 feet; commenced boring, 4 p. m., August 8, 1889; completed boring, 12 m., August 9, 1889; depth bored, 16.8 feet; time, 6 hours 15 minutes.
2	Sand and gravel	16.8	13.1	

BORING No. 6.

[Located in the Illinois River, 470 feet from south bank and 1,900 feet east of the west line of section 33, township 34 north, range 8 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	3.5	3.5	Elevation of surface of water, 56.1 feet; commenced boring, 7.30 a. m. August 9, 1889; completed boring, 3.19 p. m. August 9, 1889; depth bored, 16.1 feet; time, 5 hours 40 minutes; depth drilled, .7 foot; time, 1 hour.
2	Sand and gravel	7.5	4.0	
3	Sand-stone bowlder	8.2	0.7	
4	Sand and gravel	16.8	8.6	

BORING No. 7.

[Located in the Illinois River, 300 feet from the north bank and opposite the head of a large island in the south half of section 32, township 34 north, range 8 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	4.0	4.0	Elevation of surface of water, 55.7 feet; commenced boring, 1.45 p. m. August 9, 1889; completed boring, 11.35 a. m. August 10, 1889; depth bored, 17 feet; time, 7 hours 45 minutes.
2	Sand and gravel	17.0	13.0	

BORING No. 8.

[Located in the Illinois River, 335 feet from the north bank and 100 feet above the mouth of the Aux Sable River, in the southwest quarter of section 32, township 34 north, range 8 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	3.5	3.5	Elevation of surface of water, 55.4 feet; commenced boring, 4 p. m. August 9, 1889; completed boring, 11.30 a. m. August 10, 1889; depth bored, 16.7 feet; time, 5 hours.
2	Sand and gravel	16.7	13.2	

BORINGS IN ILLINOIS RIVER ABOVE MARSEILLES—Continued.

BORING No. 9.

[Located in the Illinois River, 172 feet from the north bank and 320 feet below the foot of a large island in the south half of section 32, township 34 north, range 8 east, Grundy County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	Elevation of surface of water, 54.5 feet; commenced boring, 1 p. m. August 12, 1889; completed boring, 12.05 p. m. August 13, 1889; depth bored, 11.3 feet; time, 3 hours; depth drilled, 4.2 feet; time, 4 hours 15 minutes.
1	Water	4.0	4.0	
2	Sand and gravel	11.3	7.3	
3	Sandstone bowlder	15.5	4.2	

BORING No. 10.

[Located in the Illinois River, 200 feet from the south bank and 2,400 feet west of the east line of section 6, township 33 north, range 8 east, Grundy County, Ill.]

		Feet.	*Fect.*	
1	Water	3.0	3.0	Elevation of surface of water, 54 feet; commenced boring, 1.30 p.m. August 10, 1889; completed boring, 2 p.m. August 12, 1889; depth bored, 14.9 feet; time, 8 hours 30 minutes; depth drilled, 1.5 feet; time, 1 hour 30 minutes.
2	Sand and gravel	10.7	7.7	
3	Sandstone bowlder	11.3	0.6	
4	Sand and gravel	11.9	0.6	
5	Sandstone bowlder	12.8	0.9	
6	Sand and gravel	16.4	3.6	

BORING No. 11.

[Located in the Illinois River, 210 feet from the north bank and 300 feet east of the west line of section 6, township 33 north, range 8 east, Grundy County, Ill.]

		Feet.	*Feet.*	Elevation of surface of water, 53.9 feet; commenced boring, 3 p.m. August 12, 1889; completed boring, 4.30 p.m. August 13, 1889; depth bored, 10 feet; time, 4 hours 5 minutes; depth drilled, 5.5 feet; time, 3 hours 20 minutes.
1	Water	4.7	4.7	
2	Sand and gravel	10.0	5.3	
3	Sandstone bowlder	15.5	5.5	

BORING No. 12.

[Located in the Illinois River, 125 feet from the north bank and 2,400 feet west of the east line of section 1, township 33 north, range 7 east, Grundy County, Ill.]

		Feet.	*Feet.*	Elevation of surface of water, 53.8 feet; commenced boring, 2.30 p.m. August 13, 1889; completed boring, 5.40 p.m. August 13, 1889; depth bored, 15.6 feet; time, 3 hours 10 minutes.
1	Water	3.1	3.1	
2	Sand and gravel	10.0	6.9	
3	Sand	12.0	2.0	
4	Sand and gravel	15.6	3.6	

BORING No. 13.

[Located in the Illinois River, 175 feet from the north bank, and 300 feet east of the west line of section 1, township 33 north, range 7 east, Grundy County, Ill.]

		Feet.	*Feet.*	Elevation of surface of water, 53.6 feet; commenced boring, 5.25 p. m. August 13, 1889; completed boring, 10.40 a. m. August 14, 1889; depth bored, 15.8 feet; time, 2 hours 55 minutes.
1	Water	6.5	6.5	
2	Sand and gravel	15.8	9.3	

BORINGS IN ILLINOIS RIVER ABOVE MARSEILLES—Continued.

BORING No. 14.

[Located in the Illinois River, 100 feet from the north bank and 430 feet below the head of a large island in the south half of section 2, township 33 north, range 7 east, Grundy County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Water	5.5	5.5	Elevation of surface of water, 53.5 feet; commenced boring, 8 a. m. August 14, 1889; completed boring, 11.40 a. m. August 14, 1889; depth bored, 16.5 feet; time, 3 hours 40 minutes.
2	Sand and gravel	15.2	9.7	
3	Quicksand	16.5	1.3	

BORING No. 15.

[Located in the Illinois River, 250 feet from the north bank, 775 feet below the foot of a large island in the south half of section 2, township 33 north, range 7 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	6.8	6.8	Elevation of surface of water, 53.4 feet; commenced boring, 1 p. m. August 14, 1889; completed boring, 3.15 p. m. August 14, 1889; depth bored, 15.4 feet; time, 2 hours 15 minutes.
2	Sand and gravel	15.4	8.6	

BORING No. 16.

[Located in the Illinois River, 200 feet from the north bank and 465 feet above the head of an island in the northeast quarter of section 10, township 33 north, range 7 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	2.5	2.5	Elevation of surface of water, 53.3 feet; commenced boring, 1 p. m. August 14, 1889; completed boring, 3 p. m. August 14, 1889; depth bored, 15.5 feet; time, 2 hours.
2	Sand	15.5	13.0	

BORING No. 17.

[Located in the Illinois River, 55 feet from the north bank and 1,230 feet below the foot of an island in the northeast quarter of section 10, township 33 north, range 7 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	6.5	6.5	Elevation of surface of water, 53.2 feet; commenced boring, 3.30 p. m. August 14, 1889; completed boring, 5.30 p. m. August 14, 1889; depth bored, 15.5 feet; time, 2 hours.
2	Sand and gravel	12.1	5.6	
3	Quicksand	15.5	3.4	

BORING No. 18.

[Located in the Illinois River, 285 feet from the north bank, 140 feet above the mouth of the Mazon River, 710 feet above the bridge over the river at Morris, Ill., and in the northeast quarter of section 9, township 33 north, range 7 east.]

		Feet.	*Feet.*	
1	Water	8.5	8.5	Elevation of surface of water, 53.1 feet; commenced boring, 4.20 p. m. August 14, 1889; completed boring, 8.30 a. m. August 15, 1889; depth bored, 15.1 feet; time, 3 hours 10 minutes.
2	Sand and gravel	15.1	6.6	

BORING No. 19.

[Located in the Illinois River, 80 feet from the south bank of the island, 200 feet below the head of the island opposite the mouth of Nettle Creek, and in the southwest quarter of section 9, township 33 north, range 7 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	2.5	2.5	Elevation of surface of water, 52.8 feet; commenced boring, 7.15 a. m. August 15, 1889; completed boring, 11.30 a. m. August 15, 1889; depth bored, 15 feet; time, 4 hours, 15 minutes.
2	Sand and gravel	13.0	10.5	
3	Quicksand	15.0	2.0	

BORINGS IN ILLINOIS RIVER ABOVE MARSEILLES—Continued.

BORING No. 20.

[Located in the Illinois River, 415 feet from the south bank and 1,300 feet west of the east line of section 8, township 33 north, range 7 east, Grundy County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Water	2.5	2.5	Elevation of surface of water, 52.6 feet; commenced boring, 9.35 a. m. August 15, 1889; completed boring, 1.40 p. m. August 15, 1889; depth bored, 15.1 feet; time, 3 hours 25 minutes.
2	Sand and gravel	13.9	11.4	
3	Quicksand	15.1	1.2	

BORING No. 21.

[Located in the Illinois River, 75 feet from the north bank, 3,000 feet above the head of Sugar Island, and in the southwest quarter of section 8, township 33 north, range 7 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	3.5	3.5	Elevation of surface of water, 52.4 feet; commenced boring, 1 p. m., August 15, 1889; completed boring, 3.15 p. m., August 15, 1889; depth bored, 15 feet; time, 2 hours 15 minutes.
2	Sand and gravel	15.0	11.5	

BORING No. 22.

[Located in the Illinois River, 365 feet from the north bank, 390 feet above the head of Sugar Island, and in the southeast quarter of section 7, township 33 north, range 7 east, Grundy County, Ill.]

		Feet.	*Feet.*	
		3.0	3.0	Elevation of surface of water 52.1 feet; commenced boring, 2.30 p. m., August 15, 1889; completed boring, 5.5 p. m. August 15, 1889; depth bored 15 feet; time, 2 hours 35 minutes.
1	Water	13.5	10.5	
2	Sand and gravel	15.0	1.5	
3	Quicksand			

BORING No. 23.

[Located in the Illinois River, 285 feet from the south bank, opposite Waupecan Creek, which is opposite the center of Sugar Island and in the southwest quarter of section 7, township 33 north range 7 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	3.2	3.2	Elevation of surface of water, 51.9 feet; commenced boring, 3.45 p. m. August 15, 1889; completed boring, 8.55 a. m. August 16, 1889; depth bored, 15 feet; time, 2 hours 50 minutes.
2	Sand and gravel	15.0	11.8	

BORING No. 24.

[Located in the Illinois River, 470 feet from the north bank, 305 feet below the foot of Sugar Island, and in the southeast quarter of section 12, township 33 north, range 6 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	2.0	2.0	Elevation of surface of water, 51.4 feet; commenced boring, 7.45 a. m. August 16, 1889; completed boring, 11 30 a. m., August 16, 1889; depth bored, 14.8 feet; time, 3 hours 45 minutes.
2	Sand and gravel	8.1	6.1	
3	Quicksand	14.8	6.7	

BORING No. 25.

[Located in the Illinois River, 110 feet from the south bank, 2,800 feet below the foot of Sugar Island, and in the northwest quarter of section 13, township 33 north, range 6 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	3.7	3.7	Elevation of surface of water, 51.4 feet; commenced boring, 9.45 a. m. August 16, 1889; Completed boring, 11.20 a. m. August 16, 1889; depth bored, 15 feet; time, 1 hour 35 minutes.
2	Sand and gravel	15.0	31.2	

Borings in Illinois River above Marseilles—Continued.

BORING No. 26.

[Located in the Illinois River, 150 feet from the south bank, 200 feet below the head of the first island below Sugar Island and on the north line of section 14, township 33 north, range 6 east, Grundy County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Water	4.7	4.7	Elevation of surface of water, 51.3 feet; commenced boring, 12.50 p. m. August 16, 1889; completed boring, 3.10 p. m. August 16, 1889; depth bored, 14.8 feet; time, 2 hours 20 minutes.
2	Sand and gravel	14.8	10.1	

BORING No. 27.

[Located in the Illinois River, 100 feet below the foot of the first island below Sugar Island, 150 feet from the south bank and in the southeast quarter of section 14, township 33 north, range 6 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	5.5	5.5	Elevation of surface of water, 51.2 feet; commenced boring 1.45 p. m. August 16, 1889; completed boring, 4 p. m. August 16, 1889; depth bored, 14.8 feet; time, 2 hours 15 minutes.
2	Sand and gravel	14.8	9.3	

BORING No. 28.

[Located in the Illinois River, 50 feet from the south bank and 25 feet east of the west line of section 14, township 33 north, range 6 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	5.0	5.0	Elevation of surface of water, 51.2 feet; commenced boring, 3.50 p. m. August 16, 1889; completed boring, 10.40 a. m. August 17, 1889; depth bored, 14 feet; time, 2 hours 45 minutes; depth drilled, .8 foot; time, 1 hour 5 minutes.
2	Sand and gravel	13.8	8.8	
3	Limestone bowlder	14.6	0.8	
4	Sand and gravel	14.8	0.2	

BORING No. 29.

[Located in the Illinois River, 50 feet from the south bank and 250 above the creek on the south side of the river, in the southwest quarter of section 15, township 33 north, range 6 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	6.0	6.0	Elevation of surface of water, 51.2 feet; commenced boring, 5. p. m. August 16, 1889; completed boring, 1.25 p. m. August 17, 1889; depth bored, 14.8 feet; time, 4 hours 15 minutes.
2	Sand and gravel	14.8	8.8	

BORING No. 30.

[Located in the Illinois River, 50 feet from the south bank and 400 feet east of the west line of section 15, township 33 north, range 6 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	5.0	5.0	Elevation of surface of water, 51.1 feet; commenced boring, 11.10 a. m. August 17, 1889; completed boring, 1.15 p. m. August 17, 1889; depth bored, 14.8 feet; time, 1 hour 35 minutes.
2	Sand	14.8	9.8	

BORING No. 31.

[Located in the Illinois River 50 feet from the south bank, one-half mile above the head of a small island which is partially in the northwest quarter of section 21, township 33 north, range 6 east, Grundy County, Ill.]

		Feet.	*Feet.*	
1	Water	5.1	5.1	Elevation of surface of water, 50.9 feet; commenced boring, 1.45 p. m. August 17, 1889; completed boring, 4.35 p. m. August 17, 1889; Depth bored, 14 feet; time, 2 hours 15 minutes; depth drilled, .8 foot; time, 35 minutes.
2	Sand and gravel	11.5	6.4	
3	Quicksand	14.0	2.5	
4	Bowlder	14.8	0.8	

BORINGS IN ILLINOIS RIVER ABOVE MARSEILLES—Continued.

BORING No. 32.

[Located in the Illinois River, 72 feet from the south bank, 200 feet below the head of a small island which is partially in the northwest quarter of section 21, township 33 north, range 6 east, Grundy County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Water	4.0	4.0	Elevation of surface of water, 50.7 feet; commenced boring, 2.45 p. m. August 17, 1889; completed boring, 10.30 a. m. August 19, 1889; depth bored, 14.5 feet; time, 4 hours 15 minutes.
2	Sand and gravel	14.5	10.5	

BORING No. 33.

[Located in the Illinois River, 110 feet from the south bank, 2,800 feet below the head of a small island which is partially in the northeast quarter of section 20, township 33 north, range 6 east, Grundy County, Ill.]

		Feet.	*Feet.*	Elevation of surface of water, 50.7 feet; commenced boring, 9.10 a. m. August 19, 1889; completed boring, 10.30 a. m. August 19, 1889; depth bored, 14.5 feet; time, 1 hour 20 minutes.
1	Water	5.2	5.2	
2	Sand and gravel	14.5	9.3	

BORING No. 34.

[Located in the Illinois River, 50 feet from the south bank and 100 feet below the mouth of the small creek in the southwest quarter of section 20, township 33 north, range 6 east, Grundy County, Ill.]

		Feet.	*Feet.*	Elevation of surface of water, 50.7 feet; commenced boring, 11.40 a. m. August 19, 1889; completed boring, 2.40 p. m. August 19, 1889; depth bored, 14.6 feet; time, 2 hours 20 minutes.
1	Water	2.7	2.7	
2	and and gravel	11.5	8.8	
3	and	14.6	3.1	

BORING No. 35.

[Located in the Illinois River, 55 feet from the south bank, one-half mile above the Seneca and Kankakee Railroad Bridge over the river, and in the southeast quarter of section 19, township 33 north, range 6 east, Grundy County, Ill.]

		Feet.	*Feet.*	Elevation of surface of water, 50.7 feet; commenced boring, 1.20 p. m. August 19, 1889; completed boring, 11.10 a. m. August 20, 1889; depth bored, 14.5 feet; time, 6 hours 30 minutes.
1	Water	2.9	2.9	
2	Sand and gravel	14.5	11.6	

BORING No. 36.

[Located in the Illinois River, 50 feet from the south bank, 250 above the Seneca and Kankakee Railroad Bridge over the river, and in the northwest quarter of section 30, township 33 north, range 6 east, Grundy County, Ill.]

		Feet.	*Feet.*	Elevation of surface of water, 50.6 feet; commenced boring, 3.45 p. m. August 19, 1889; completed boring, 5 p. m. August 19, 1889; depth bored, 14.5 feet; time, 1 hour 15 minutes.
1	Water	5.5	5.5	
2	Sand and gravel	14.5	9.0	

BORING No. 37.

[Located in the Illinois River, 55 feet from the south bank, 2,200 feet below the Seneca and Kankakee Railroad Bridge over the river, and in the southeast quarter of section 25, township 33 north, range 5 east, La Salle County, Ill.]

		Feet.	*Feet.*	Elevation of surface of water, 50.6 feet; commenced boring, 10 a. m. August 20, 1889; completed boring, 1.30 p. m. August 20, 1889; depth bored, 14.5 feet; time, 2 hours 45 minutes.
1	Water	5.0	5.0	
2	Sand and gravel	9.0	4.0	
3	Quicksand	11.2	2.2	
4	Sand and gravel	14.5	3.3	

Borings in Illinois River above Marseilles—Continued.

BORING No. 38.

[Located in the Illinois River, 75 feet from the south bank, about 2,300 feet above the Seneca Wagon Bridge over the river, 50 feet below the quarter section line fence on the north side of the river and in the southwest quarter of section 25, township 33 north, range 5 east, La Salle County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Water	4.3	4.3	Elevation of surface of water, 50.6 feet; commenced boring, 2.15 p. m. August 20, 1889; completed boring, 4.05 p. m. August 20, 1889; depth bored, 14.5 feet; time, 1 hour 50 minutes.
2	Gravel	5.3	1.0	
3	Sand	14.5	9.2	

BORING No. 39.

[Located in the Illinois River, 150 feet from the south bank, 510 feet below the Seneca Wagon Bridge over the river and in the southeast quarter of section 26, township 33 north, range 5 east, La Salle County, Ill.]

		Feet.	*Feet.*	
1	Water	5.0	5.0	Elevation of surface of water, 50.6 feet; commenced boring, 3.35 p. m. August 20, 1889; completed boring, 8.50 a. m. August 21, 1889; depth bored, 14.5 feet; time, 2 hours 15 minutes.
2	Sand, gravel, and cobble-stones.	14.5	9.5	

BORING No. 40.

[Located in the Illinois River, 45 feet from the south bank, 3,000 feet below the Seneca wagon bridge over the river, and in the southwest quarter of section 26, township 33 north, range 5 east, La Salle County, Ill.]

		Feet.	*Feet.*	
1	Water	4.5	4.5	Elevation of surface of water, 50.6 feet; commenced boring, 9.5 a. m.; August 21, 1889; completed boring, 12 m.; August 21, 1889; depth bored, 14.5 feet; time, 2 hours 55 minutes.
2	Sand, gravel, and cobble-stones.	9.2	4.7	
3	Sand and gravel	14.5	5.3	

BORING No. 41.

[Location in the Illinois River, 25 feet from the north bank, 410 feet above the mouth of Rat Run, and in the southeast quarter of section 27, township 33 north, range 5 east, La Salle County, Ill.]

		Feet.	*Feet.*	
1	Water	4.0	4.0	Elevation of surface of water, 50.5 feet; commenced boring, 11 a. m. August 21, 1889; completed boring, 1.45 p. m. August 21, 1889; depth bored, 7.5 feet; time, 15 minutes; depth drilled, 7 feet; time, 2 hours.
2	Sand	7.5	3.5	
3	Soapstone rock	13.6	6.1	
4	Sandstone rock	14.5	0.9	

BORING No. 42.

[Located in the Illinois River, 20 feet from the south bank, one-half mile below Rat Run, and in the northwest quarter of section 27, township 33 north, range 5 east, La Salle County, Ill.]

		Feet.	*Feet.*	
1	Water	4.0	4.0	Elevation of surface of water, 50.4 feet; commenced boring, 2.20 p. m. August 21, 1889; completed boring, 8.55 a. m. August 22, 1889; depth bored, 8.7 feet; time, 40 minutes; depth drilled, 5.8 feet; time, 3 hours 20 minutes.
2	Sand and gravel	8.7	4.7	
3	Soapstone rock	12.7	4.0	
4	Sandstone rock	14.5	1.8	

BORINGS IN ILLINOIS RIVER ABOVE MARSEILLES—Continued.

BORING No. 43.

[Located in the Illinois River, 100 feet from the south bank, 295 feet below the mouth of the creek which is partially in the south half of section 22, township 33 north, range 5 east, La Salle County, Ill.]

No.		Depth.	Thickness.	Remarks.
		Feet.	*Feet.*	
1	Water	3.0	3.0	Elevation of surface of water, 50.3 feet; commenced boring, 3.10 p.m. August 21, 1889; completed boring, 11.35 a.m. August 22, 1889; depth bored, 3 feet; depth drilled, 11.5 feet; time, 6 hours.
2	Slate	3.4	0.4	
3	Soapstone rock	6.3	2.9	
4	Sandstone rock	6.7	0.4	
5	Soapstone rock	8.1	1.4	
6	Sandstone rock	10.2	2.1	
7	Soapstone rock	14.5	4.3	

BORING No. 44.

[Located in the Illinois River, 160 feet from the south bank, opposite the mouth of North Kickapoo Creek, and in the southeast quarter of section 21, township 33 north, range 5 east, La Salle County, Ill.]

		Feet.	*Feet.*	
1	Water	4.0	4.0	Elevation of surface of water, 50.3 feet; commenced boring, 9.50 a.m. August 22, 1889; completed boring, 12 m. August 22, 1889; depth bored, 4 feet; depth drilled, 2.9 feet; time, 2 hours 10 minutes.
2	Sandstone rock	6.9	2.9	

BORING No. 45.

[Located in the Illinois River, 150 feet from the north bank, 250 feet below the foot of the island in the south half of section 21, township 33 north, range 5 east, La Salle County, Ill.]

		Feet.	*Feet.*	
1	Water	4.0	4.0	Elevation of surface water, 50.2 feet. Commenced boring 1 p.m. August 22, 1889; completed boring, 5.5 p.m. August 22, 1889; depth bored, 9.9 feet; time, 2 hours, 30 minutes; depth drilled, 2.6 feet; time, 1 hour 35 minutes.
2	Sand and gravel	9.9	5.9	
3	Sandstone rock	12.5	2.6	

BORING No. 46.

[Located in the Illinois River, 125 feet from the north bank opposite the mouth of South Kickapoo Creek, and in the northeast quarter of section 20, township 33 north, range 5 east, La Salle County Ill.]

		Feet.	*Feet.*	
1	Water	2.9	2.9	Elevation of surface of water, 50.2 feet; commenced boring, 1.55 p.m. August 22, 1889; completed boring, 5.45 p.m. August 22, 1889; depth bored, 2.9 feet; depth drilled, 4.6 feet; time 3 hours 50 minutes.
2	Sandstone rock	7.5	4.6	

NOTE.—From this boring down to the Marseilles Dam the river bottom is rock.

EXAMINATIONS AND BORINGS ALONG THE DES PLAINES AND ILLINOIS RIVERS AT SPECIAL PLACES TO DETERMINE THE MATERIAL FORMING THE BED.

Borings were made along the east bank of the basin between the two dams at Joliet and in the basin itself. At the upper end of the basin the rock is thinly covered with gravel, and at the lower end is a deposit of mud varying from 1.5 to 4.5 feet over the rock.

Along the line of the proposed canal between the present canal and the head of Lake Joliet, rock could not be reached, the material met being gravel and bowlders.

At the head of Lake Joliet an excavation had been made 7 feet below water-surface, showing only gravel and bowlders.

In Lake Joliet, 2,000 feet below where the proposed canal enters it, the bottom is mud to a depth of 10 feet.

At the head of Treats Island and in both channels rock was not reached, the material penetrated being sand, gravel, and bowlders. At the foot of the island and in the river below rock was found, the bed in the middle of the stream being bare rock.

At Smith's Bridge, rock was met at 5.5 feet below the water-surface. At the mouth of the Du Page River, rock was not met at 6 feet below the water-surface, the material being gravel and bowlders. A depth of 11.7 feet below water-surface was reached, 3,000 feet below Du Page River, without meeting rock. At a point 1,000 feet below Kankakee feeder aqueduct, rock was found at 3.4 feet below the water-surface. From this point to below the Kankakee River, the bed of the river is rock. From 1 mile below the Kankakee River to Marseilles, borings were made under contract and published herewith.

From the Marseilles Rapids to a short distance above Utica, the river-bed is either bare rock or rock thinly overlaid with sand and gravel. Borings were made every half mile throughout this reach, and the rock shown to have nearly the same slope as the water-surface.

From Utica to the Illinois and Michigan Canal at La Salle, borings were put down each half mile from 12.5 to 16 feet below the water-surface, penetrating only sand and mud. No rock was met in this portion of the river.

List of bridges over Chicago River between Lake Michigan and Bridgeport.

Name of bridge.	Distance from mouth of river.	Iron or wood.	Steam or hand power.	Number of openings.	Opening between center pier and abutments.		Clear opening of draw.		Character of abutments. Stone, wood, or pile.		Diameter of center pier.	Character of center pier.	Distance from face of abutments to dock lines.		Length of bridge.	Width of bridge.	Roadway, single or double.	Width of sidewalks.	Distance of guard piles from face of abutments.		Angle of bridge with river channel.	Cost.
					L.	R.	L.	R.	L.	R.			L.	R.					L.	R.		
	Feet.				*Feet.*	*Feet.*	*Feet.*	*Feet.*			*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	°	
Illinois Central R. R.	400	I.	H.	2	81.4	81.4	78.7	78.7	P.	P.	31.7	S.	.....	.....	203.4	17.6	S.	.....	.....	.....	85	
Rush Street	2,900	I.	S.	2	81.5	86.9	73.0	74.4	S.	S.	53.0	S.	47.0	15.0	240.0	43.5	D.	7.0	3.0	7.0	90	$138,019.85
State Street	3,900	I.	S.	2	79.0	77.0	60.0	62.0	S.	S.	29.7	S.	25.0	35.0	185.6	24.2	S.	7.0	7.0	8.0	87	
Dearborn Street	4,300	W & I	S.	2	75.0	70.7	60.0	60.2	S.	S.	30.0	S.	42.5	31.5	189.8	21.8	S.	6.0	7.5	3.0	87	
Clark Street	4,700	I.	S.	2	80.5	72.5	67.5	62.5	S.	S.	53.0	S.	19.5	37.0	214.4	43.4	D.	7.5	3.0	5.0	89	
Wells Street	5,500	I.	S.	2	78.2	78.3	70.3	67.0	S.	S.	53.0	S.	37.0	44.0	221.5	43.5	D.	7.0	.....	3.0	88	150,440.00
Lake Street	6,900	I.	S.	2	78.9	74.5	71.0	65.0	S.	S.	53.0	S.	39.5	18.0	220.0	45.7	D.	7.0	3.0	4.0	83	
Randolph Street	7,500	I.	S.	2	64.0	64.0	53.0	53.0	P.	P.	25.5	P.	17.0	17.0	158.0	19.8	S.	6.0	6.0	6.0	84	
Madison Street	8,300	I.	S.	2	61.0	55.0	51.5	48.0	S.	S.	25.5	S.	6.5	2.0	158.0	22.0	S.	6.0	3.5	1.0	90	
Adams Street	9,200	I.	S.	1	.....	88.0	.....	87.0	S.	S.	53.0	S.	.....	18.0	254.0	43.5	D.	7.5	.....	4.0	78	
Jackson Street	9,700	I.	S.	1	.....	104.0	.....	91.5	S.	S.	53.0	S.	.....	20.0	280.0	43.5	D.	7.0	.....	5.5	80	131,632.67
Van Buren Street	10,200	W & I	H.	2	62.5	68.0	51.5	57.0	S.	S.	25.6	S.	23.5	17.0	165.0	22.0	S.	6.0	5.0	4.0	80	
Harrison Street	11,100	I.	H.	2	68.1	69.1	58.0	62.0	P.	P.	27.8	P.	.....	40.9	177.0	20.5	S.	6.0	6.0	3.0	70	
Polk Street	12,000	I.	H.	2	57.0	59.0	51.0	48.0	S.	S.	26.3	S.	35.0	6.0	165.0	19.8	S.	5.5	2.0	7.0	85	
Wisconsin Central R. R.	13,200	I.	S.	2	53.9	59.9	52.0	58.0	P.	P.	33.0	S.	.....	.....	286.0	28.8	D.	.....	.....	.....	40	
Twelfth Street	13,700	I.	S.	2	68.7	69.7	58.0	64.0	S.	S.	53.0	S.	11.0	25.0	220.4	43.5	D.	6.0	5.0	.....	55	
Chicago, Burlington and Quincy R. R.	16,700	I.	S.	2	65.2	61.0	62.4	58.2	S.	S.	40.0	S.	.....	.....	297.3	33.6	D.	.....	.....	.....	35	
Eighteenth Street	17,900	I.	H.	2	65.4	65.9	51.5	57.0	S.	S.	31.4	S.	.....	7.5	176.0	23.5	S.	6.5	9.5	4.5	85	67,300.00
Pittsburgh, Fort Wayne and Chicago R. R.	18,900	I.	S.	2	55.3	54.3	53.0	51.0	S.	S.	32.6	S.	.....	.....	231.0	26.5	D.	.....	5.5	6.0	50	
Twenty-second Street	20,300	W & I	H.	2	51.5	59.0	47.0	50.5	P.	P.	27.9	P.	.....	.....	211.2	21.5	S.	5.0	.....	4.0	53	
Halsted Street	22,700	I.	H.	2	58.0	57.0	47.0	50.0	P.	P.	26.0	P.	23.0	17.0	152.0	19.8	S.	6.0	5.0	4.0	40	
Main Street	25,900	W & I	H.	2	51.0	53.0	46.0	48.0	P.	P.	26.0	P.	.....	.....	153.0	26.0	S.	5.0	.....	.....	80	
Deering Street	27,000	W & I	H.	2	.....	.....	65.0	39.0	P.	P.	30.0	P.	.....	.....	196.0	24.0	S.	5.0	6.5	.....	65	58,000.00
Ashland Avenue	28,600	W & I	H.	2	67.0	74.0	62.0	68.0	P.	P.	19.0	P.	27.0	47.0	165.0	24.0	S.	5.5	5.0	.....	75	

Report of the vessel dispatcher's office from April 17 to December 1, 1888, between the hours of 8 a. m. and 9 p. m.

Bridges.	Days in service.	Time open.	Vessels passed through.	Total swings.	Average vessels per day.	Average swings per day.	Average vessels per swing.
		h. m.					
Rush	196	485 52	14, 866	6, 566	75. 34+	33. 5 −	2. 26+
State	196	399 37	14, 517	6, 043	74. 06+	30. 84+	2. 40+
Clark	196	416 4	14, 102	5 083	71. 94+	25. 93+	2. 77+
Wells	84	151 54	5, 983	2 472	71. 22+	29. 42+	2. 42+
Lake	196	345 16	10, 932	5, 638	55. 77+	28. 75+	1. 93+
Randolph	195	327 46	10, 854	5, 723	55. 66+	29. 34+	1. 89+
Madison	196	319 43	10, 783	5, 188	55. 01+	26. 46+	2. 07+
Adams	196	329 45	10, 754	5, 476	54. 86+	27. 93+	1. 96+
Van Buren	195	342 13	10, 717	5, 310	54. 95+	27. 23+	2. 02+
Harrison	188	415 38	10, 373	4, 967	55. 17+	26. 42+	2. 08+
Polk	92	191 10	4, 880	2, 565	53. 04+	27. 88+	1. 90+
Twelfth	196	368 58	10, 545	6, 268	53. 80+	31. 97+	1. 68+
Kinzie	195	500 5	15, 728	6, 800	80. 65+	34. 87+	2. 31+
Indiana	196	221 27	4, 753	3, 717	24. 25—	18. 96+	1. 27+
Erie	161	194 26	3, 990	3, 101	24. 78+	19. 26+	1. 28+
Chicago avenue	194	179 36	4, 789	3, 752	24. 68+	19. 34+	1. 27+

Bridges.	Average time consumed per vessel.	Average time open per swing.	Average time open per hour.	Average time open per day.	Time bridge was closed for public.	Time bridge was open for vessels.
	m. s.	*m. s.*	*m. s.*	*m. s.*	*Per cent.*	*Per cent.*
Rush	1 58	4 26	11 26	148 42	$80\frac{13}{19}$	$19\frac{1}{19}$
State	1 39	3 58	9 25	122 18	$84\frac{8}{25}$	$15\frac{17}{25}$
Clark	1 46	4 55	9 47	127 18	$83\frac{13}{19}$	$16\frac{6}{19}$
Wells	1 31	3 41	8 20	108 30	$86\frac{7}{25}$	$13\frac{18}{25}$
Lake	1 53	3 40	8 8	105 36	$86\frac{6}{19}$	$13\frac{13}{19}$
Randolph	1 49	3 26	7 45	100 48	$87\frac{3}{50}$	$12\frac{47}{50}$
Madison	1 46	3 41	7 31	97 48	$87\frac{35}{75}$	$12\frac{40}{75}$
Adams	1 50	3 37	7 46	100 54	$87\frac{4}{75}$	$12\frac{71}{75}$
Van Buren	1 56	3 55	8 13	106 48	$86\frac{6}{17}$	$13\frac{10}{17}$
Harrison	2 24	5 1	10 12	132 36	$82\frac{33}{46}$	$17\frac{13}{50}$
Polk	2 21	4 28	11 31	124 36	$80\frac{13}{17}$	$19\frac{4}{17}$
Twelfth	2 5	3 32	8 41	112 54	$85\frac{29}{38}$	$14\frac{18}{38}$
Kinzie	1 54	4 25	11 50	153 48	$80\frac{4}{15}$	$19\frac{11}{15}$
Indiana	2 47	3 34	5 25	67 42	$91\frac{3}{25}$	$8\frac{17}{25}$
Erie	2 56	3 47	5 37	73 00	$90\frac{13}{20}$	$9\frac{7}{20}$
Chicago avenue	2 15	2 52	4 16	55 30	$92\frac{11}{12}$	$7\frac{1}{12}$

NOTE.—These tables include the busiest hours of the day. All bridges are closed between 6 and 8 a. m., and 5 and 7 p. m. The per cents. of time bridges were open for vessels have evidently been obtained by dividing the total time bridges were open by the whole time from 8 a. m. to 9 p. m., *including the two hours bridges were not opened at all* The per cents. should therefore be multiplied by $\frac{12}{11}$ to obtain the per cent. representing the interruption to street traffic.

L. L. W.

Elevations of high waters between Joliet and La Salle, Ill.

Locality.	Distance in 1,000 feet.	Elevation.	Date.	Authority.	Cause.	Remarks.
Upper Dam, Joliet	0	113.4				Indefinite.
Guard Lock*	2	104.4	August 10, 1866	S. M. Thorpe, Joliet	Rain-storm	Mark on lock-wall.
Do	2	103.9	April 4, 1877	Do		Mark on lock-wall. Day and month questionable.
Do	2	103.8	February 9, 1883	Do		Mark on lock-wall.
Do	2	100.7	April 18, 1889	Do		Gauge reading.
Adams Dam	5	97.3	February 8, 1877	J. H. Adams, Joliet		Mark on river-bank. Day and month questionable.
Foot of Treat's Island	48	78.4				Ice-mark. Summer floods reach an equal elevation.
Smith's Bridge	55	80.6	February, 1866	G. Alexander, Channahon		Year in doubt. Mark on bowlder.
Do	57	81.6	March, 1883	Chas. Smith, Channahon	Ice-gorge	Notch cut in tree.
Do	59	80.5	Summer, 1866	S. B. Whitmore, Channahon		Do.
Do	59	81.0	Winter, 1866	Do		Notch in tree. Year in doubt.
Do	59	81.1	Winter, 1866	Do		Do. do.
Do	59	82.3	Spring, 1883	Do	Ice-gorge	Mark on bowlder.
Kankakee Feeder	77	81.0	Summer, 1866	James Long, Channahon		Possible error of 1 foot, as water height is an estimated distance above crotch of tree.
Do	77	82.5	Spring, 1887	do		
A. J. & N. R. R	92	75.6	April, 1887	L. Liberty, Minooka		Corner of porch to residence.
Aux Sable Township	107	77.5	January, 1883	M. E. Redmond, Morris		Mark on corn-crib.
Do	113	74.5	July 4, 1844	William White, Morris		Mark indefinite.
Do	113	76.6	Spring, 1883	A. Boyea, Morris		Possible error of 2 feet.
Morris, Ill	132	73.8	do	H. Hoyt, Morris		Mark indefinite.
Do	132	73.9	do	J. Gatling, Morris		Nails in door-sill of blacksmith-shop.
Do	132	78.1	1866	do		Some question as to accuracy and year.
Do	132	75.3	March, 1867	J. M. Griggs, Morris		Cut in stone foundation to residence.
Do	132	74.1	1887	do		Some question as to accuracy.
Foot of Sugar Island	148	67.1				Ice mark.
Do	148	73.1	1867	W. K. Johnson, Morris		Mark indefinite.
S. & K. R. R. Bridge	168	67.8	1883	R. Callahan, Seneca		Corner of shed; year in doubt.
Do	169	68.7				Ice marks.
Do	179	65.9	Spring, 1887	D. Walsh, Seneca		Mark on pier of railroad bridge.
Seneca, Ill	186	66.6	do	W. H. Underhill, Seneca		Ice-gorge at Rat Run; mark on bowlder.
Do	189	65.9	Fall, 1882	H. G. Lansing, Seneca		Mark indefinite; year doubtful.
Ballard's Island	200	56.0	June, 1889	C. W. Green, Marseilles		One foot above top of fence-posts.
Do	213	59.0				Ice mark in north channel.
Do	212	58.3	June, 1869	Mrs. E. B. Hackshaw, Marseilles.		Mark on fence-post in south channel.
Ballard's Island	212	57.0	Feb'y, 1887	do		Indefinite mark in south channel.
Marseilles, Ill	215	58.1	June, 1867	G. A. Campbell, Marseilles		Some doubt as to year, probably 1869.
Do	215	57.3	Spring, 1883	do		Mark on stone in levee.
Do	215	55.2	Spring, 1887	do		Water came to foot small tree.
Do	231	49.8	Spring, 1867	L. G. Douglas, Marseilles	Ice-gorge	Mark indefinite.

*Note—Dam No. 2 is curved 200 feet in length. Zero of gauge on guard-lock is at an elevation of 98.3. Crest of dam is at an elevation of 99.3.

Elevations of high waters between Joliet and La Salle, Ill.—Continued.

Locality.	Distance in 1,000 feet.	Elevation.	Date.	Authority.	Cause.	Remarks.
Marseilles, Ill	231	54.2				Ice marks not reliable.
Do	231	49.8				Ice marks.
Ottawa, Ill	247	40.7	Spring, 1885	P. Phalin, Ottawa		Mark indefinite in north channel.
Do	247	43.2	Spring, 1882	J. Bodach, Ottawa		Year doubtful, corner of shed in south channel.
Do	247	39.5	Spring, 1885	do		Foot of tree in south channel.
Do	253	44.9	Spring, 1883	A. Lynch, Ottawa		Mark on tree.
Do	254	45.1	Spring, 1883	M. Hennepin, Ottawa		Mark on well.
Do	255	45.1	Spring, 1883	E. B. Singer, Ottawa		Mark on pier of highway bridge.
Do	255	49.2	Spring, 1857	Col. D. F. Hitt, Ottawa		Unreliable, as bridge has been moved.
Do	266	36.6				Ice mark.
Do	275	36.3	June, 1869	A. Edwards, Ottawa		Mark indefinite.
Do	275	40.5	Spring, 1883	do		Mark on door-sill of residence.
Buffalo Rock	278	34.0	June, 1869	G. Lewis, Ottawa		Mark indefinite.
Do	283	34.5	Summer, 1866	F. Fishburne, Ottawa		Mark indefinite, year doubtful.
Do	283	40.9	Spring, 1883,	do		Foot of fence-post, south channel.
Do	290	33.6				Ice mark.
Do	293	35.7				Do
Do	295	33.4				Ice mark on island.
Starved Rock	300	34.6	Spring, 1857	Col. D. F. Hitt, Ottawa		Notch cut in tree.
Do	300	36.1	Spring, 1883	C. E. Randlett, Utica	Ice-gorge	Do
Do	301	36.1	Spring, 1883	do	do	Do
Utica, Ill	311	30.3				Ice mark.
Little Rock Ferry	317	31.7	Spring, 1883	T. Keith, La Salle		Mark on house.
Do	317	31.7	Spring, 1883	do		Mark on stump.
Peru, Ill	340	25.9				Ice mark.
Do	340	29.5				Mark on house.

Gauge-readings on the Illinois River above Copperas Creek Dam, Ill.

[Readings are referred to upper miter-sill of lock, which is 5 feet above lower miter-sill.]

1879.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	7.00	7.10	7.50	10.90	9.85	7.40	6.95	7.33	6.62	6.65	6.95	7.47
2	7.00	7.22	7.45	10.90	9.65	7.42	6.95	7.27	6.78	6.52	6.90	7.50
3	6.90	7.37	7.45	10.97	9.40	7.30	6.90	7.17	6.70	6.68	6.93	7.57
4	6.90	7.50	7.45	11.03	9.20	7.23	7.00	7.18	6.60	6.63	6.95	7.63
5	6.90	7.63	7.45	11.00	9.00	7.28	7.00	7.12	6.53	6.67	6.93	7.65
6	6.90	7.70	7.68	10.95	8.80	7.30	6.95	7.18	6.50	6.58	6.98	7.67
7	6.90	7.78	7.92	10.90	8.60	7.25	7.00	7.15	6.45	6.63	6.92	7.67
8	6.85	7.80	8.10	10.80	8.35	7.17	7.00	7.10	6.40	6.65	6.85	7.75
9	6.85	7.85	8.45	10.70	8.15	7.10	7.15	7.02	6.42	6.63	7.03	7.75
10	6.80	7.90	9.00	11.05	7.98	6.98	7.62	7.03	6.40	6.53	7.13	7.75
11	6.80	7.90	9.48	11.12	7.75	7.02	8.07	6.98	6.37	6.62	7.10	7.86
12	6.75	8.00	9.82	11.23	7.65	7.07	8.33	7.03	6.48	6.73	7.15	7.85
13	6.75	7.90	10.13	11.45	7.62	7.08	8.50	7.02	6.45	6.80	7.15	7.85
14	6.75	7.90	10.45	11.68	7.57	7.03	8.57	7.10	6.47	6.80	7.15	7.93
15	6.70	7.85	10.60	11.87	7.52	7.02	8.68	7.08	6.20	6.80	7.12	8.02
16	6.70	7.85	10.85	11.95	7.47	7.03	8.63	7.08	6.25	6.70	7.12	8.05
17	6.70	7.85	11.07	11.95	7.45	7.00	8.63	7.00	6.45	6.73	7.17	8.05
18	6.70	7.85	11.15	11.95	7.40	7.05	8.55	6.95	6.52	6.80	7.15	8.00
19	6.70	7.85	11.20	11.88	7.38	7.00	8.40	6.95	6.50	6.83	7.12	7.90
20	6.70	7.85	11.20	11.75	7.35	6.95	8.35	6.92	6.50	6.77	7.10	7.90
21	6.70	7.85	11.25	11.60	7.40	6.98	8.20	6.87	6.47	6.80	7.15	7.85
22	6.70	7.80	11.25	11.47	7.30	7.00	8.12	6.88	6.50	6.80	7.15	7.85
23	6.70	7.65	11.20	11.33	7.22	7.00	8.12	6.90	6.62	6.80	7.12	7.80
24	6.75	7.60	11.08	11.20	7.17	6.95	7.97	6.92	6.62	6.80	7.10	7.80
25	6.75	7.60	11.05	11.05	7.07	6.92	7.82	6.85	6.58	6.80	7.18	7.75
26	6.75	7.60	11.00	10.85	7.00	6.95	7.77	6.80	6.50	6.83	7.20	7.75
27	6.75	7.55	10.95	10.58	6.98	6.95	7.68	6.72	6.47	6.80	7.20	7.80
28	6.80	7.50	10.90	10.48	7.08	7.00	7.57	6.70	6.50	6.80	7.53	7.80
29	6.88	.....	10.85	10.30	7.18	7.02	7.50	6.63	6.53	6.83	7.48	7.75
30	6.95	.....	10.88	10.10	7.35	6.98	7.50	6.60	6.52	6.90	7.45	7.75
31	7.02	.....	10.85	.....	7.43	.....	7.43	6.63	.....	6.95	.....	7.70
Monthly mean	6.81	7.71	9.86	11.17	7.85	7.08	7.77	6.97	6.50	6.74	7.12	7.79

1880.

1	7.65	11.45	10.77	10.20	12.20	11.52	9.85	7.52	7.33	7.10	7.00	6.70
2	7.65	11.32	10.82	10.40	12.30	11.42	9.88	8.07	7.40	7.05	6.98	6.70
3	7.60	11.18	10.87	10.58	12.32	11.27	9.88	7.92	7.48	7.10	6.98	6.70
4	8.60	11.00	10.90	10.68	12.35	11.15	9.77	7.75	7.53	7.30	6.95	6.70
5	8.77	10.78	10.95	10.78	12.32	11.05	9.90	7.60	7.48	7.30	7.00	6.65
6	8.88	10.60	10.95	10.92	12.20	10.87	9.80	7.52	7.47	7.35	6.98	6.65
7	9.30	10.40	10.95	11.02	12.05	10.75	9.75	7.50	7.40	7.35	7.00	6.65
8	9.72	10.23	11.00	11.10	12.00	10.65	9.68	7.43	7.40	7.35	7.00	6.65
9	10.00	10.05	11.00	11.10	11.90	10.55	9.53	7.38	7.40	7.35	7.00	6.70
10	10.22	9.83	10.95	11.10	12.48	10.40	9.40	7.30	7.40	7.30	6.97	6.70
11	10.47	9.77	10.90	11.10	12.75	10.25	9.32	7.30	7.35	7.30	6.90	6.70
12	10.75	9.90	10.82	11.00	13.10	10.10	9.20	7.25	7.35	7.30	7.00	6.70
13	11.00	9.85	10.77	10.78	13.40	9.90	9.10	7.22	7.30	7.27	7.00	6.70
14	11.30	9.85	10.63	10.60	13.58	9.85	9.03	7.17	7.28	7.17	7.05	6.70
15	11.33	9.83	10.48	10.50	13.68	9.80	8.88	7.07	7.25	7.17	7.00	6.70
16	11.43	9.77	10.32	10.43	13.67	9.67	8.73	7.00	7.22	7.30	7.00	6.70
17	11.50	9.63	10.20	10.25	13.65	9.68	8.67	6.95	7.18	7.15	7.00	6.70
18	11.53	9.92	10.02	10.05	13.55	9.80	8.53	7.00	7.15	7.20	6.97	6.65
19	11.55	9.93	9.85	9.87	13.40	9.88	8.42	6.97	7.15	7.17	6.90	6.65
20	11.55	10.00	9.65	9.77	13.22	10.05	8.35	6.95	7.20	7.12	6.85	6.65
21	11.55	10.00	9.45	9.60	13.05	10.00	8.27	6.92	7.25	7.10	6.80	6.60
22	11.55	10.05	9.32	9.45	12.92	10.15	8.13	6.90	7.25	7.05	6.75	6.60
23	11.55	10.05	9.15	9.40	12.75	10.15	7.97	6.90	7.25	7.02	6.75	6.60
24	11.50	10.10	9.00	9.60	12.50	10.15	7.95	6.85	7.25	6.95	6.75	6.70
25	11.52	10.18	8.77	10.33	12.25	10.15	7.83	6.90	7.20	6.92	6.75	6.75
26	11.55	10.28	8.67	10.55	12.02	10.13	7.83	6.93	7.25	6.90	6.75	6.80
27	11.60	10.43	8.60	11.05	11.95	10.02	7.85	6.90	7.25	6.95	6.75	6.85
28	11.60	10.57	9.02	11.50	11.75	9.95	7.78	7.02	7.20	7.00	6.75	6.80
29	11.60	10.67	9.28	11.85	11.57	9.90	7.73	7.10	7.17	7.00	6.75	6.80
30	11.57	.....	9.55	12.13	11.63	9.87	7.65	7.25	7.15	6.90	6.70	6.75
31	11.55	.....	9.92	.....	11.63	.....	7.60	7.20	.....	6.93	.....	6.75
Monthly mean	10.58	10.26	10.11	10.59	12.59	10.31	8.78	7.22	7.30	7.14	6.90	6.70

Gauge-readings on the Illinois River above Copperas Creek Dam, Ill.—Continued.

[Readings are referred to upper miter-sill of lock, which is 5 feet above lower miter-sill.]

1881.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	6.70	6.65	11.92	15.07	14.60	8.23	9.20	7.25	6.85	7.00	8.68	13.42
2	6.65	6.60	12.20	14.98	14.40	8.08	8.95	7.25	6.85	7.05	8.73	13.27
3	6.65	6.60	12.80	14.78	14.22	7.98	8.65	7.25	6.78	7.13	8.75	13.25
4	6.60	6.65	13.10	14.57	14.05	7.80	8.40	7.25	6.75	7.15	8.70	13.18
5	6.60	6.65	13.38	14.35	13.85	7.83	8.20	7.25	6.80	7.20	8.70	13.10
6	6.60	6.65	13.70	14.15	13.70	8.05	8.02	7.22	6.73	7.13	8.70	13.05
7	6.60	6.87	13.85	13.90	13.45	8.40	7.85	7.20	6.70	7.15	8.70	13.00
8	6.60	7.40	14.00	13.80	13.25	8.73	7.62	7.15	6.80	7.18	8.75	12.95
9	6.60	7.78	14.05	13.73	13.05	9.15	7.40	7.10	6.80	7.30	8.75	12.85
10	6.60	8.48	14.05	13.72	12.85	9.50	7.35	7.15	6.75	7.30	8.80	12.82
11	6.60	8.75	14.20	13.80	12.60	9.78	7.38	7.15	6.83	7.25	9.12	12.68
12	6.60	9.38	14.50	13.95	12.40	10.10	7.30	7.15	6.82	7.30	9.45	12.55
13	6.60	9.65	14.75	14.20	12.25	10.40	7.30	7.10	6.80	7.38	9.95	12.65
14	6.60	10.00	14.98	14.40	12.05	10.70	7.50	7.10	6.82	7.45	10.38	12.73
15	6.60	10.37	15.20	14.60	11.85	11.00	7.47	7.05	6.80	7.52	11.03	12.90
16	6.60	10.53	15.50	14.85	11.67	11.25	7.38	7.02	6.80	7.62	11.65	13.30
17	6.60	10.65	15.70	15.05	11.50	11.28	7.37	7.02	6.80	7.75	12.18	13.70
18	6.60	10.85	15.97	15.22	11.30	11.25	7.27	7.00	6.80	7.90	12.73	14.10
19	6.60	11.05	16.20	15.40	11.10	11.20	7.22	6.90	6.78	8.05	13.15	14.30
20	6.60	11.17	16.37	15.65	10.95	11.12	7.10	6.90	6.83	8.20	13.45	14.47
21	6.60	11.25	16.47	15.85	10.77	11.00	7.05	6.85	6.85	8.25	13.58	14.57
22	6.65	11.32	16.40	15.98	10.60	10.80	7.08	6.85	6.80	8.30	13.82	14.67
23	6.65	11.40	16.18	15.97	10.35	10.60	7.07	6.87	6.75	8.30	13.92	14.83
24	6.65	11.40	15.82	15.87	10.15	10.40	7.00	6.90	6.75	8.32	14.05	15.05
25	6.65	11.37	15.65	15.75	9.95	10.20	7.05	6.90	6.70	8.37	14.05	15.52
26	6.65	11.38	15.48	15.60	9.75	9.97	7.10	6.85	6.70	8.43	14.02	15.98
27	6.60	11.55	15.37	15.42	9.50	9.75	7.12	6.85	6.75	8.42	13.82	16.28
28	6.60	11.72	15.27	15.25	9.25	9.85	7.18	6.85	6.85	8.47	13.72	16.40
29	6.60	.....	15.18	15.05	8.97	9.65	7.23	6.85	6.65	8.58	13.65	16.40
30	6.65	.....	15.15	14.85	8.70	9.47	7.20	6.75	6.67	8.65	13.53	16.28
31	6.65	.....	15.15	.....	8.58	.....	7.23	6.80	.....	8.65	.....	16.15
Monthly mean	6.62	9.43	14.79	14.86	11.67	9.78	7.52	7.03	6.78	7.77	11.28	14.08

1882.

1	15.95	10.27	12.20	13.92	12.65	13.62	15.35	8.60	7.58	7.05	7.35	7.45
2	15.65	10.10	12.45	13.75	12.70	13.60	15.20	8.45	7.75	7.02	7.38	7.40
3	15.40	10.05	12.92	13.65	12.70	13.77	14.90	8.32	7.80	7.13	7.40	7.45
4	15.05	10.02	13.37	13.48	12.60	13.93	14.55	8.22	7.85	7.20	7.40	7.42
5	14.62	9.92	13.82	13.33	12.63	14.07	14.35	8.17	7.88	7.12	7.40	7.50
6	14.30	9.82	14.10	13.23	12.70	14.35	14.07	8.20	7.85	7.10	7.35	7.45
7	14.10	9.72	14.28	13.10	12.75	14.55	13.80	8.27	7.85	7.10	7.35	7.40
8	13.72	9.60	14.35	12.92	12.88	14.58	13.52	8.27	7.80	7.10	7.32	7.40
9	13.60	9.55	14.40	12.85	12.90	14.55	13.27	8.28	7.78	7.20	7.30	7.35
10	13.35	9.47	14.45	12.80	12.85	14.58	13.10	8.23	7.68	7.27	7.38	7.30
11	13.22	9.40	14.45	12.72	12.90	14.85	12.90	8.23	7.60	7.35	7.40	7.30
12	13.05	9.32	14.45	12.70	13.05	15.17	12.70	8.30	7.58	7.30	7.43	7.25
13	12.85	9.30	14.45	12.70	13.42	15.57	12.50	8.25	7.53	7.30	7.48	7.25
14	12.65	9.30	14.40	12.68	13.65	15.82	12.30	8.17	7.42	7.30	7.47	7.20
15	12.45	9.30	14.30	12.60	13.85	15.87	12.05	8.10	7.40	7.35	7.52	7.15
16	12.28	9.35	14.22	12.53	13.95	15.80	11.77	8.07	7.35	7.38	7.50	7.15
17	12.15	9.43	14.12	12.42	13.88	15.83	11.55	7.98	7.35	7.45	7.52	7.15
18	11.97	9.50	14.10	12.32	13.72	15.80	11.35	7.90	7.30	7.40	7.58	7.15
19	11.80	9.63	14.12	12.22	13.55	15.65	11.20	7.77	7.25	7.40	7.65	7.15
20	11.65	9.80	14.27	12.12	13.35	15.40	11.00	7.67	7.25	7.40	7.58	7.20
21	11.57	10.00	14.47	11.95	13.20	15.15	10.77	7.57	7.25	7.40	7.65	7.42
22	11.47	10.25	14.50	11.82	13.00	14.90	10.55	7.52	7.18	7.40	7.63	7.65
23	11.33	10.42	14.45	11.82	12.80	14.80	10.30	7.47	7.10	7.40	7.60	7.92
24	11.20	10.60	14.45	11.85	12.60	14.60	10.10	7.50	7.15	7.40	7.60	8.13
25	11.10	11.00	14.40	11.80	12.53	14.42	9.85	7.70	7.15	7.40	7.60	8.27
26	11.02	11.30	14.33	11.83	12.35	14.40	9.60	7.58	7.10	7.40	7.55	8.43
27	10.87	11.60	14.22	12.00	12.70	14.50	9.35	7.53	7.10	7.35	7.55	8.53
28	10.73	11.90	14.10	12.12	12.90	14.75	9.15	7.50	7.10	7.35	7.55	8.68
29	10.65	.....	14.10	12.30	13.30	15.20	8.90	7.50	7.08	7.30	7.50	8.75
30	10.57	.....	14.05	12.55	13.60	15.33	8.70	7.50	7.05	7.30	7.45	8.80
31	10.43	.....	14.00	.....	13.73	.....	8.87	7.55	.....	7.35	.....	8.85
Monthly mean	12.60	10.00	14.07	12.60	13.08	14.85	11.86	7.95	7.44	7.29	7.48	7.66

Gauge-readings on the Illinois River above Copperas Creek Dam, Ill.—Continued.

[Readings are referred to upper miter-sill of lock, which is 5 feet above lower miter-sill.]

1883.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	8.93	7.05	18.85	11.82	12.30	11.93	11.55	9.90	7.00	6.90	7.70	11.40
2	9.00	7.00	18.60	11.70	12.10	11.90	11.45	9.87	7.00	6.95	7.75	11.40
3	8.88	7.00	18.35	11.58	11.92	11.85	11.25	9.82	7.02	6.95	7.73	11.40
4	8.72	7.00	18.25	11.50	11.80	11.80	11.07	9.67	7.00	6.95	7.83	11.30
5	8.57	7.00	18.30	11.60	11.65	11.72	10.97	9.55	7.00	6.95	7.88	11.30
6	8.48	7.00	18.25	11.73	11.52	11.63	10.80	9.35	6.97	6.97	8.02	11.20
7	8.38	7.00	18.00	12.00	11.47	11.52	10.67	9.17	6.90	7.02	8.25	11.08
8	8.30	6.95	17.67	12.32	11.32	11.37	10.55	8.92	6.90	7.02	8.45	11.00
9	8.23	7.02	17.32	12.70	11.22	11.48	10.35	8.70	6.90	6.95	8.90	10.88
10	8.07	7.12	17.00	13.03	11.22	11.40	10.20	8.50	6.85	7.00	9.20	10.78
11	7.97	7.20	16.70	13.30	11.38	11.40	10.05	8.30	6.80	7.07	9.45	10.65
12	7.87	7.27	16.40	13.43	11.55	11.45	9.85	8.17	6.83	7.08	9.73	10.53
13	7.73	7.37	16.08	13.62	11.80	11.45	9.67	8.02	6.80	7.05	9.85	10.38
14	7.65	7.50	15.75	13.65	12.10	11.48	9.62	7.85	6.75	7.05	10.00	10.28
15	7.60	7.87	15.38	13.62	12.32	11.55	9.42	7.72	6.75	7.05	10.10	10.13
16	7.52	9.65	15.12	13.55	12.53	11.63	9.23	7.57	6.75	7.02	10.15	9.97
17	7.45	11.17	14.82	13.50	12.57	11.78	9.27	7.47	6.77	6.97	10.10	9.83
18	7.40	12.42	14.52	13.50	12.63	11.92	9.20	7.37	6.80	7.00	10.10	9.80
19	7.35	14.62	14.32	13.42	12.73	11.98	9.00	7.27	6.73	7.13	10.00	9.50
20	7.27	16.67	14.13	13.30	12.70	12.00	8.95	7.32	7.08	7.17	10.05	9.33
21	7.20	18.05	13.85	13.15	12.60	12.10	8.95	7.25	6.78	7.27	10.07	9.20
22	7.20	18.90	13.62	12.90	12.65	12.15	8.77	7.20	6.85	7.25	10.12	8.95
23	7.15	19.30	13.40	12.88	12.52	12.15	8.68	7.20	6.77	7.25	10.17	8.90
24	7.15	19.55	13.22	13.00	12.37	12.15	8.65	7.20	6.77	7.30	10.32	9.03
25	7.10	19.75	13.00	13.13	12.17	12.07	8.80	7.12	6.70	7.33	10.55	9.00
26	7.10	19.55	12.80	13.10	12.05	11.98	9.02	7.12	6.72	7.30	10.73	8.77
27	7.05	19.40	12.67	12.97	11.85	11.90	9.33	7.05	6.73	7.30	10.95	8.68
28	7.05	19.15	12.50	12.80	11.80	11.87	9.63	7.05	6.80	7.30	11.15	8.45
29	7.05	.....	12.30	12.67	11.83	11.75	9.83	7.05	6.80	7.40	11.30	8.35
30	7.05	.....	12.13	12.50	11.87	11.67	9.93	7.05	6.82	7.47	11.38	8.35
31	7.05	.....	11.95	.....	11.93	.....	9.90	7.05	.....	7.60	.....	8.30
Monthly mean	7.73	11.63	15.33	12.80	12.02	11.77	9.83	8.03	6.84	7.13	9.60	9.91

1884.

1	8.23	7.72	14.82	16.75	11.55	9.00	8.03	7.65	6.98	7.53	8.03	7.67
2	8.05	7.93	14.60	16.68	11.42	8.90	7.95	7.62	6.90	7.68	8.00	7.62
3	8.00	8.20	14.35	16.53	11.30	8.93	7.88	7.70	6.93	7.88	7.95	7.55
4	8.00	8.52	14.07	16.35	11.20	8.83	7.80	7.70	6.95	7.90	7.92	7.55
5	8.00	9.22	13.85	16.08	11.12	8.70	7.78	7.65	6.90	7.95	7.90	7.58
6	8.00	9.60	13.65	15.82	11.18	8.65	7.73	7.62	6.90	7.95	7.93	7.68
7	8.00	9.95	13.43	15.50	11.27	8.52	7.65	7.58	7.00	8.47	7.97	7.82
8	8.00	10.28	13.27	15.23	11.32	8.45	7.63	7.53	6.98	8.92	8.07	8.02
9	7.93	10.70	13.02	14.93	11.35	8.55	7.60	7.45	6.95	9.32	8.03	8.22
10	7.90	11.07	12.82	14.60	11.35	8.50	7.77	7.38	6.88	9.68	8.00	8.38
11	7.85	11.45	12.65	14.32	11.35	8.40	8.20	7.30	6.95	10.03	8.00	8.52
12	7.83	11.87	12.52	14.05	11.35	8.33	8.58	7.30	6.93	10.20	8.00	8.60
13	7.75	12.42	12.40	13.80	11.38	8.28	8.80	7.23	6.90	10.20	7.97	8.55
14	7.70	12.73	12.30	13.55	11.45	8.13	8.80	7.18	6.85	10.17	7.90	8.52
15	7.70	12.98	12.20	13.35	11.45	8.02	8.77	7.08	6.78	10.03	7.85	8.50
16	7.67	13.25	12.15	13.15	11.35	7.93	8.68	7.03	6.83	9.90	7.80	8.48
17	7.60	13.52	12.18	12.95	11.25	7.87	8.57	6.93	6.80	9.75	7.75	8.33
18	7.55	13.82	12.30	12.80	11.15	7.82	8.45	6.85	6.80	9.58	7.75	8.27
19	7.50	14.27	12.48	12.68	11.07	7.93	8.35	6.80	6.75	9.35	7.65	8.10
20	7.50	14.62	12.67	12.62	10.97	7.97	8.18	6.78	6.80	9.15	7.53	7.98
21	7.47	14.97	12.92	12.53	10.87	8.00	8.00	6.88	6.75	9.00	7.50	7.92
22	7.43	15.28	13.23	12.45	10.75	8.13	7.88	6.85	6.87	8.85	7.53	7.87
23	7.38	15.48	13.57	12.43	10.60	8.10	7.80	6.80	7.42	8.72	7.83	7.78
24	7.30	15.60	13.92	12.30	10.43	8.12	7.75	6.80	7.80	8.53	7.77	7.72
25	7.30	15.65	14.30	12.18	10.25	8.15	7.70	6.67	7.70	8.47	7.78	7.65
26	7.30	15.65	14.82	12.07	10.10	8.17	7.67	6.78	7.57	8.40	7.85	7.63
27	7.25	15.58	15.32	11.92	9.95	8.20	7.80	6.80	7.57	8.32	7.85	7.57
28	7.23	15.40	15.83	11.75	9.80	8.20	7.80	6.97	7.48	8.23	7.83	7.58
29	7.20	15.07	16.37	11.65	9.65	8.15	7.78	7.10	7.52	8.20	7.80	7.90
30	7.32	.....	16.63	11.52	9.45	8.10	7.73	7.05	7.45	8.20	7.75	8.95
31	7.67	.....	16.73	.....	9.22	.....	7.68	7.00	.....	8.10	.....	10.05
Monthly mean	7.66	12.51	13.72	13.75	10.87	8.30	8.03	7.16	7.06	8.86	7.85	8.08

Gauge-readings on the Illinois River above Copperas Creek Dam, Ill.—Continued.

[Readings are referred to upper miter-sill of lock, which is 5 feet above lower miter-sill.]

1885.

Day.	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	10.52	11.98	8.80	13.40	14.17	8.70	7.58	7.68	7.87	8.03	9.40	10.00
2	11.18	11.83	8.75	13.48	14.00	8.63	7.48	7.62	7.87	8.00	9.43	9.97
3	11.82	11.72	8.85	13.52	13.80	8.60	7.40	7.75	7.72	7.90	9.35	9.90
4	12.50	11.63	9.17	13.62	13.55	8.60	7.28	7.72	7.65	7.92	9.47	9.80
5	12.97	11.55	9.68	13.67	13.35	8.67	7.23	7.73	7.53	7.90	9.53	9.75
6	13.58	11.43	10.15	13.70	13.18	8.70	7.20	7.78	7.43	8.03	9.70	9.60
7	14.15	11.37	10.52	13.75	12.98	8.70	7.15	7.93	7.38	8.00	9.82	9.53
8	14.55	11.28	10.85	13.75	12.82	8.75	7.10	7.95	7.47	7.88	10.07	9.40
9	14.82	11.23	11.23	13.75	12.60	8.75	7.17	7.97	7.60	7.90	10.25	9.40
10	14.88	11.13	11.85	13.73	12.40	8.72	7.35	7.92	7.50	8.08	10.60	9.33
11	14.97	11.03	12.08	13.68	12.20	8.62	7.68	7.87	7.57	8.22	10.93	9.30
12	15.05	10.88	12.32	13.60	12.05	8.55	7.92	7.90	7.77	8.28	11.02	9.30
13	14.80	10.75	12.70	13.50	11.85	8.55	8.22	7.72	8.07	8.25	11.47	9.20
14	14.52	10.62	13.10	13.40	11.70	8.53	8.23	7.58	8.35	8.07	11.57	9.20
15	14.35	10.53	13.50	13.28	11.52	8.48	8.00	7.43	8.32	7.95	11.67	9.10
16	14.10	10.40	13.92	13.18	11.35	8.38	7.83	7.38	8.32	7.83	11.63	9.00
17	13.93	10.28	14.28	13.32	11.15	8.23	7.70	7.25	8.27	7.77	11.38	8.87
18	13.75	10.15	14.47	13.45	11.00	8.10	7.63	7.23	8.23	7.77	11.33	8.67
19	13.55	10.03	14.52	13.60	10.85	7.97	7.48	7.32	8.40	7.80	11.37	8.57
20	13.40	9.90	14.60	13.82	10.65	7.88	7.37	7.25	8.28	7.98	11.40	8.53
21	13.20	9.78	14.57	14.07	10.47	7.88	7.32	7.07	8.38	8.03	11.30	8.53
22	13.03	9.63	14.50	14.25	10.30	7.88	7.22	6.98	8.30	8.23	11.22	8.53
23	12.93	9.50	14.40	14.45	10.10	7.80	7.28	6.93	8.18	8.47	11.07	8.87
24	12.85	9.38	14.23	14.63	9.90	7.73	7.18	7.20	8.13	8.78	10.83	9.20
25	12.78	9.28	14.05	14.75	9.70	7.70	7.20	7.63	8.10	8.82	10.78	9.20
26	12.63	9.13	13.85	14.83	9.47	7.65	7.43	7.82	8.07	8.90	10.70	9.45
27	12.53	9.00	13.65	14.80	9.25	7.65	7.15	7.93	8.07	9.03	10.70	9.72
28	12.43	8.88	13.47	14.70	9.02	7.65	7.37	8.12	8.07	9.22	10.45	10.00
29	12.33	.....	13.40	14.58	8.87	7.65	7.30	8.20	8.13	9.33	10.27	10.43
30	12.20	.....	13.40	14.40	8.77	7.63	7.35	8.07	8.20	9.40	10.17	10.70
31	12.13	.....	13.40	.....	8.70	.....	7.68	8.03	.....	9.40	.....	11.02
Monthly mean	13.30	10.51	12.52	13.89	11.35	8.24	7.47	7.64	7.97	8.30	10.63	9.42

1886.

1	11.37	11.75	14.83	14.00	11.98	12.35	7.53	6.65	6.70	7.10	7.10	6.85
2	11.73	11.60	14.70	13.85	11.85	12.15	7.43	6.63	6.70	7.05	7.03	6.87
3	11.98	11.45	14.50	13.65	11.70	11.82	6.28	6.57	6.70	7.07	7.00	6.83
4	12.20	11.30	14.38	13.48	11.68	11.60	7.20	6.55	6.75	7.10	6.93	6.80
5	12.38	11.15	14.20	13.35	11.70	11.35	7.12	6.55	6.80	7.15	6.93	6.83
6	12.75	11.00	14.00	13.20	11.68	11.07	7.05	6.55	6.80	7.15	6.92	6.85
7	12.98	10.80	13.80	13.20	11.68	10.85	7.00	6.58	6.80	7.15	6.95	6.90
8	13.25	10.63	13.62	13.15	11.58	10.65	7.00	6.55	6.80	7.10	7.00	6.90
9	13.32	10.53	13.45	12.95	11.50	10.45	6.95	6.55	6.80	7.05	7.05	6.87
10	13.30	10.55	13.30	12.90	11.50	10.18	6.95	6.55	6.83	7.05	7.00	6.90
11	13.23	10.77	13.12	12.90	11.50	9.95	6.95	6.55	6.72	7.02	7.00	6.95
12	13.15	11.17	12.93	12.93	11.53	9.68	6.90	6.55	6.75	7.00	6.92	6.97
13	12.98	11.50	12.75	12.75	11.50	9.45	6.90	6.70	6.73	7.00	6.90	6.93
14	12.90	11.88	12.62	12.68	11.63	9.22	6.83	6.90	6.78	6.95	6.90	6.87
15	12.85	12.18	12.53	12.60	11.80	9.02	6.80	6.90	6.80	6.95	6.83	6.80
16	12.80	12.73	12.42	12.77	12.10	8.88	6.80	6.85	6.83	6.95	6.80	6.80
17	12.75	13.43	12.32	12.88	12.45	8.75	6.75	6.90	7.00	6.95	6.78	6.78
18	12.70	14.20	12.35	13.05	12.90	8.55	6.75	6.90	7.00	6.95	6.70	6.70
19	12.65	14.80	12.35	13.22	13.35	8.38	6.75	6.80	6.95	6.95	6.75	6.67
20	12.58	15.00	12.45	13.30	13.60	8.25	6.75	6.70	6.95	6.92	6.80	6.65
21	12.45	15.28	12.60	13.35	13.80	8.05	6.75	6.70	6.95	6.93	6.83	6.60
22	12.35	15.35	12.88	13.30	13.92	7.93	6.75	6.70	7.00	7.02	6.90	6.60
23	12.30	15.35	13.33	13.23	13.90	7.87	6.70	8.70	6.98	7.03	6.95	6.55
24	12.23	15.30	13.82	13.03	13.90	7.80	6.70	6.67	7.03	7.05	6.93	6.60
25	12.15	15.27	14.17	12.93	13.80	7.80	6.70	6.80	7.05	7.10	6.98	6.60
26	12.03	15.30	14.40	12.83	13.62	7.75	6.65	6.80	7.13	7.15	7.00	6.60
27	11.95	15.15	14.50	12.68	13.45	7.75	6.65	6.80	7.15	7.10	7.00	6.55
28	12.07	14.95	14.38	12.48	13.23	7.68	6.65	6.80	7.15	7.10	7.00	6.55
29	12.05	.....	14.33	12.25	13.05	7.60	6.65	6.80	7.12	7.10	7.00	6.50
30	12.00	.....	14.22	12.08	12.80	7.55	6.65	6.80	7.10	7.10	6.93	6.50
31	11.90	.....	14.10	.....	12.55	.....	6.65	6.80	.....	7.10	.....	6.50
Monthly mean	12.49	12.87	13.53	13.03	12.49	9.35	6.88	6.70	6.89	7.04	6.93	6.74

Gauge readings on the Illinois River above Copperas Creek Dam, Ill.—Continued.

[Readings are referred to upper miter sill of lock, which is 5 feet above lower miter sill.]

1887.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	6.50	9.57	15.85	10.72	7.60	6.70	6.50	6.50	6.45	6.80	6.65	6.85
2	6.50	9.50	15.60	10.60	7.57	6.70	6.50	6.50	6.45	6.80	6.65	6.90
3	6.50	9.50	15.25	10.48	7.52	6.70	6.50	6.50	6.57	6.80	6.60	7.02
4	6.50	9.40	14.95	10.32	7.50	6.70	6.50	6.50	6.65	6.80	6.60	7.05
5	6.55	9.40	14.73	10.00	7.50	6.70	6.53	6.50	6.70	6.75	6.60	7.10
6	6.55	9.42	14.50	9.90	7.52	6.82	6.55	6.50	6.70	6.80	6.60	7.10
7	6.55	9.60	14.33	9.80	7.52	6.85	6.55	6.50	6.70	6.75	6.60	7.15
8	6.55	10.03	14.17	9.60	7.50	6.85	6.52	6.50	6.75	6.75	6.60	7.20
9	6.55	10.17	13.95	9.33	7.45	6.92	6.50	6.55	6.75	6.80	6.60	7.25
10	6.60	10.80	13.80	9.13	7.45	7.00	6.50	6.55	6.75	6.85	6.60	7.30
11	6.60	12.66	13.70	9.00	7.40	7.00	6.50	6.55	6.75	6.85	6.60	7.30
12	6.70	13.77	13.60	8.90	7.30	7.10	6.50	6.55	6.75	6.80	6.60	7.30
13	6.70	14.77	13.48	8.82	7.22	7.10	6.45	6.55	6.70	6.80	6.60	7.30
14	6.70	15.87	13.37	8.72	7.15	7.00	6.45	6.55	6.70	6.75	6.60	7.35
15	6.75	16.40	13.30	8.70	7.15	6.95	6.45	6.60	6.70	6.70	6.55	7.35
16	6.70	16.80	13.20	8.70	7.10	6.90	6.50	6.60	6.70	6.70	6.60	7.35
17	6.75	16.90	13.05	8.60	7.10	6.80	6.50	6.60	6.60	6.70	6.65	7.35
18	6.75	16.97	12.83	8.60	7.10	6.75	6.50	6.60	6.60	6.70	6.67	7.35
19	6.75	17.20	12.58	8.30	7.10	6.70	6.50	6.60	6.60	6.70	6.70	7.35
20	6.95	17.40	12.42	8.03	7.07	6.70	6.50	6.60	6.60	6.63	6.70	7.30
21	7.13	17.55	12.32	7.90	7.00	6.65	6.50	6.60	6.60	6.65	6.70	7.30
22	7.50	17.65	12.20	7.88	7.00	6.60	6.50	6.60	6.65	6.65	6.70	7.30
23	7.72	17.35	12.05	7.80	7.00	6.60	6.50	6.60	6.70	6.70	6.75	7.30
24	7.80	17.10	11.87	7.70	6.95	6.53	6.45	6.55	6.70	6.70	6.75	7.30
25	7.80	16.80	11.70	7.70	6.88	6.50	6.45	6.55	6.70	6.65	6.75	7.30
26	8.10	16.55	11.58	7.70	6.85	6.50	6.50	6.55	6.70	6.65	6.80	7.30
27	8.50	16.35	11.50	7.70	6.80	6.50	6.50	6.50	6.73	6.60	6.80	7.30
28	8.93	16.13	11.43	7.70	6.75	6.50	6.50	6.50	6.85	6.60	6.80	7.30
29	9.30	.....	11.28	7.70	6.70	6.50	6.50	6.50	6.85	6.60	6.80	7.30
30	9.60	.....	11.05	7.65	6.70	6.50	6.50	6.50	6.80	6.60	6.85	7.30
31	9.70	.....	10.88	.....	6.70	.....	6.50	6.50	.....	6.60	.....	7.30
Monthly mean	7.25	13.99	13.11	8.79	7.17	6.75	6.50	6.54	6.68	6.72	6.67	7.24

1888.

1	7.25	7.65	12.10	13.78	9.13	11.43	8.00	7.72	6.80	6.30	6.65	6.80
2	7.25	7.65	12.70	13.97	8.93	11.90	8.12	7.60	6.80	6.30	6.65	6.80
3	7.25	7.65	13.03	13.88	8.80	11.90	8.23	7.55	6.80	6.33	6.70	6.80
4	7.25	7.65	13.20	13.73	8.70	12.00	8.38	7.50	6.80	6.40	6.70	6.80
5	7.25	7.65	13.43	13.65	8.60	12.13	8.45	7.40	6.80	6.40	6.70	6.80
6	7.50	7.60	13.55	13.48	8.50	12.18	8.50	7.40	6.80	6.50	6.70	6.80
7	7.60	7.60	13.58	13.25	8.27	12.10	8.57	7.40	6.80	6.50	6.77	6.85
8	7.60	7.55	13.50	13.07	8.03	12.10	8.67	7.40	6.75	6.50	6.87	6.85
9	7.65	7.55	13.40	12.90	8.27	11.97	9.20	7.40	6.70	6.55	7.03	6.85
10	7.65	7.50	13.40	12.67	8.43	11.80	9.57	7.40	6.70	6.60	7.05	6.90
11	7.65	7.50	13.40	12.50	8.50	11.68	9.70	7.40	6.70	6.60	7.05	6.90
12	7.68	7.50	13.40	12.37	8.42	11.32	9.75	7.35	6.70	6.60	7.05	6.88
13	7.70	7.50	13.27	12.17	8.40	11.10	9.80	7.30	6.65	6.60	7.00	6.85
14	7.75	7.60	13.10	12.07	8.43	10.93	9.85	7.30	6.65	6.60	7.00	6.80
15	7.75	7.70	13.03	12.00	8.40	10.67	9.90	7.20	6.65	6.65	7.00	6.80
16	7.75	7.75	12.90	11.92	8.33	10.37	9.90	7.20	6.65	6.65	7.00	6.80
17	7.80	7.80	12.80	11.80	8.30	10.15	9.80	7.27	6.65	6.70	6.90	6.83
18	7.80	7.90	12.70	11.62	8.30	9.97	9.70	7.25	6.68	6.70	6.90	6.88
19	7.85	8.03	12.70	11.35	8.20	9.78	9.62	7.30	6.70	6.75	7.00	6.93
20	7.85	8.40	12.62	11.17	8.20	9.40	9.33	7.30	6.70	6.80	7.00	6.77
21	7.85	8.80	12.60	10.95	8.10	9.23	9.15	7.20	6.70	6.80	6.90	6.72
22	7.85	9.40	12.73	10.78	8.10	9.13	8.92	7.15	6.77	6.80	6.90	6.70
23	7.85	9.80	12.70	10.67	8.00	9.00	8.78	7.13	6.80	6.85	6.90	6.70
24	7.80	10.33	12.67	10.47	8.05	8.93	8.60	7.10	6.80	6.85	6.82	6.70
25	7.75	11.00	12.60	10.23	8.23	8.83	8.50	7.10	6.77	6.80	6.80	6.67
26	7.70	11.00	12.73	10.05	8.43	8.72	8.40	7.10	6.65	6.80	6.80	6.70
27	7.70	11.00	12.90	9.83	9.03	8.55	8.45	7.10	6.50	6.70	6.80	6.77
28	7.70	11.30	13.07	9.73	9.60	8.33	8.27	7.05	6.40	6.70	6.80	6.92
29	7.70	11.73	13.47	9.53	10.10	8.20	8.05	7.00	6.40	6.70	6.80	7.00
30	7.70	.....	13.63	9.30	10.60	8.03	7.92	6.95	6.30	6.70	6.80	7.00
31	7.70	.....	13.67	.....	11.05	.....	7.88	6.90	.....	6.70	.....	7.08
Monthly mean	7.65	8.55	13.05	11.83	8.66	10.39	8.90	7.27	6.69	6.63	6.87	6.83

Gauge readings on the Illinois River above Copperas Creek Dam, Ill.—Continued.

[Readings are referred to upper miter sill of lock, which is 5 feet above lower miter sill.]

1889.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	7.10	7 38	7.30	7.85	7.70	7.20	11.02	8.15	6.60	6.80	6.90	6.90
2	7.10	7.30	7.70	7.80	7.60	7.20	11.85	8.10	6.60	6.73	7.00	6.87
3	7.10	7.30	8.00	7.80	7.50	7.23	10.75	8.10	6.60	6.70	7.00	6.90
4	7.10	7.28	8.23	7.87	7.40	7.60	10.65	8.00	6.60	6.70	7.00	6.90
5	7.10	7.25	8.40	7.90	7.23	7.87	10.40	7.95	6.65	6.70	7.07	6.90
6	7.10	7.20	8.45	7.82	7.30	8.13	10.10	7.82	6.70	6.70	7.10	7.00
7	7.13	7.07	8.65	7.80	7.22	8.20	9.88	7.70	6.70	6.70	7.17	7.03
8	7.18	7.10	8.80	7.80	7.12	9.20	9.70	7.60	6.70	6.70	7.35	7.20
9	7.22	7.10	8.90	7.80	7.10	9.52	9.52	7.52	6.83	6.70	7.40	7.32
10	7.20	7.10	8.90	7.80	7.03	9.60	9.30	7.40	7.05	6.70	7.40	7.65
11	7.18	7.10	8.90	7.70	7.00	9.60	9.08	7.32	7.22	6.65	7.35	7.80
12	7.20	7.10	8.80	7.70	7.00	9.63	9.00	7.22	7.35	6.65	7.30	7.88
13	7.27	7.07	8.80	7.70	7.00	9.55	8.87	7.20	7.50	6.70	7.25	7.93
14	7.38	7.00	8.73	7.70	7.05	9.53	8.68	7.10	7.50	6.70	7.20	8.10
15	7.45	7.00	8.70	7.70	7.00	9.60	8.60	7.10	7.57	6.70	7.20	8.17
16	7.47	7.00	8.70	7.67	7.00	9.72	8.60	7.00	7.57	6.80	7.20	8.27
17	7.55	7.00	8.60	7.60	7.00	9.88	8.77	6.93	7.55	6.80	7.20	8.37
18	7.72	7.00	8.52	8.60	7.00	10.07	8.93	6.90	7.50	6.80	7.20	8.40
19	7.78	7.00	8.50	8.10	7.00	10.30	9.05	6.90	7.42	6.80	7.20	8.40
20	7.80	7.05	8.50	8.20	7.05	10.57	9.20	6.90	7.30	6.80	7.12	8.40
21	7.70	7.08	8.43	8.27	7.10	10.82	9.20	6.90	7.20	6.75	7.05	8.40
22	7.60	7.10	8.42	8.30	7.10	10.95	9.10	6.85	7.08	6.75	7.00	8.40
23	7.57	7.20	8.25	8.30	7.05	11.10	9.00	6.80	7.05	6.70	7.00	8.40
24	7.60	7.20	8.15	8.23	7.00	11.15	9.00	6.75	7.00	6.70	6.90	8.35
25	7.65	7.20	8.10	8.20	7.00	11.15	8.92	6.70	7.00	6.70	6.85	8.40
26	7.65	7.20	8.10	8.10	7.00	11.20	8.78	6.70	6.90	6.70	6.90	8.33
27	7.70	7.20	8.05	8.00	7.00	11.25	8.67	6.72	6.90	6.70	6.90	8.32
28	7.65	7.20	8.00	8.00	7.00	11.27	8.50	6.65	6.83	6.70	6.90	8.30
29	7.57	.....	7.97	7.90	7.07	11.20	8.42	6.60	6.80	6.70	6.90	8.30
30	7.50	.....	7.90	7.83	7.13	11.12	8.28	6.60	6.80	6.70	6.90	8.30
31	7.42	.....	7.90	.....	7.20	.....	8.20	6.60	.....	6.85	.....	8.25
Monthly mean	7.41	7.14	8.37	7.90	7.13	9.71	9.26	7.19	7.04	6.73	7.10	7.88

MONTHLY MEANS.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly means.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1879	6.81	7.71	9.86	11.17	7.85	7.08	7.77	6.97	6.50	6.74	7.12	7.79	7.78
1880	10.58	10.26	10.11	10.59	12.59	10.31	8.78	7.22	7.30	7.14	6.90	6.70	9.04
1881	6.62	9.43	14.79	14.86	11.67	9.78	7.52	7.03	6.78	7.77	11.28	14.08	10.13
1882	12.00	10.00	14.07	12.60	13.08	14.85	11.86	7.95	7.44	7.29	7.48	7.66	10.57
1883	7.73	11.63	15.33	12.80	12.02	11.77	9.83	8.03	6.84	7.13	9.60	9.91	10.22
1884	7.66	12.51	13.72	13.75	10.87	8.30	8.03	7.16	7.06	8.86	7.85	8.08	9.49
1885	13.30	10.51	12.52	13.89	11.35	8.24	7.47	7.64	7.97	8.30	10.63	9.42	10.10
1886	12.49	12.87	13.53	13.03	12.49	9.35	6.88	6.70	6.89	7.04	6.93	6.74	9.58
1887	7.25	13.99	13.11	8.79	7.17	6.75	6.50	6.54	6.68	6.72	6 67	7.24	8.12
1888	7.65	8.55	13.05	11.83	8.66	10.39	8.90	7.27	6.69	6.63	6.87	6.83	8.61
1889	7.41	7.14	8.37	7.90	7.13	9.71	9.26	7.19	7.04	6.73	7.10	7.88	7.74
Mean for 11 yrs.	9.10	10.42	12.59	11.93	10.44	9.68	8.44	7.25	7.02	7.30	8.04	8 39	9.22

Gauge readings on the Illinois River below Copperas Creek Dam, Ill.—Continued.

[Readings are referred to lower miter-sill of lock, which is 5 feet below low water of 1873 and 1879.]

1879.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	7.75	9.10	10.15	15.47	14.55	8.53	7.30	8.60	5.77	5.57	6.50	8.38
2	7.70	9.40	10.03	15.50	14.35	8.60	7.18	8.32	5.90	5.48	6.47	8.43
3	7.70	9.87	9.95	15.50	14.05	8.48	7.02	8.15	5.95	5.62	6.58	8.65
4	7.70	10.30	9.83	15.55	13.85	8.30	7.05	8.00	5.80	5.68	6.60	8.87
5	7.70	10.73	9.63	15.60	13.60	8.30	7.02	7.92	5.62	5.70	6.55	9.02
6	7.70	11.00	9.75	15.55	13.35	8.22	7.00	7.92	5.48	5.60	6.55	9.05
7	7.70	11.20	10.12	15.45	13.02	8.12	7.03	7.85	5.38	5.52	6.55	9.10
8	7.70	11.45	10.82	15.38	12.70	8.02	7.05	7.68	5.28	5.67	6.52	9.12
9	7.70	11.65	11.47	15.38	12.32	8.00	7.58	7.47	5.25	5.53	6.67	9.32
10	7.65	11.80	12.40	15.60	11.90	7.88	8.32	7.43	5.17	5.67	6.95	9.48
11	7.65	11.93	13.13	15.72	11.50	7.72	9.28	7.28	5.02	5.83	7.02	9.53
12	7.65	11.90	13.70	15.83	11.17	7.75	10.40	7.20	5.05	5.90	7.15	9.58
13	7.65	11.85	14.18	16.00	10.85	7.70	11.02	7.33	5.12	6.25	7.23	9.77
14	7.65	11.85	14.52	16.28	10.52	7.53	11.42	7.40	5.12	6.25	7.23	9.97
15	7.65	11.80	14.82	16.45	10.27	7.47	11.65	7.43	5.12	6.30	7.22	10.22
16	7.65	11.80	15.07	16.55	9.88	7.48	11.73	7.35	4.98	6.18	7.27	10.42
17	7.65	11.80	15.45	16.60	9.62	7.48	11.77	7.23	5.03	6.13	7.32	10.52
18	7.65	11.80	15.57	16.60	9.32	7.45	11.70	7.05	5.12	6.13	7.45	11.08
19	7.65	11.80	15.70	16.53	9.20	7.37	11.57	6.87	5.17	6.27	7.40	11.35
20	7.65	11.80	15.70	16.45	9.03	7.25	11.40	6.72	5.10	6.25	7.45	11.48
21	7.65	11.75	15.75	16.30	8.90	7.22	11.15	6.60	5.15	6.30	7.43	11.50
22	7.65	11.70	15.80	16.20	8.70	7.30	11.03	6.48	5.15	6.32	7.45	11.35
23	7.65	11.47	15.75	16.07	8.42	7.23	10.85	6.55	5.15	6.30	7.40	11.08
24	7.65	11.30	15.70	15.90	8.20	7.18	10.60	6.60	5.48	6.27	7.30	11.10
25	7.65	11.08	15.63	15.70	8.07	7.10	10.32	6.50	5.40	6.20	7.38	11.10
26	7.65	10.75	15.55	15.52	8.02	7.05	10.15	6.30	5.25	6.15	7.47	11.15
27	7.75	10.58	15.55	15.38	7.95	7.15	9.90	6.10	5.17	6.17	7.53	11.27
28	7.95	10.43	15.50	15.20	7.97	7.23	9.60	5.97	5.22	6.23	8.20	11.37
29	8.17	.....	15.45	15.00	8.07	7.35	9.32	5.83	5.22	6.37	8.40	11.40
30	8.52	.....	15.43	14.75	8.30	7.40	9.10	5.73	5.35	6.45	8.40	11.40
31	8.88	.....	15.40	.....	8.50	.....	8.80	5.75	.....	6.55	.....	11.35
Monthly mean.	7.76	11.20	13.66	15.80	10.52	7.66	9.53	7.09	5.30	6.03	7.19	10.24

1880.

1	11.30	16.05	15.27	14.55	16.88	16.35	14.30	9.10	7.70	7.33	6.67	6.65
2	11.08	15.97	15.35	14.75	17.03	16.17	14.32	9.83	8.00	7.20	6.55	6.65
3	10.93	15.83	15.43	14.93	17.10	16.00	14.32	9.85	8.22	7.25	6.50	6.65
4	11.87	15.65	15.47	15.15	17.10	15.87	14.22	9.75	8.57	7.60	6.50	6.65
5	12.27	15.45	15.55	15.33	17.07	15.70	14.33	9.52	8.53	7.70	6.52	6.52
6	12.72	15.30	15.55	15.43	16.95	15.57	14.20	9.35	8.50	7.87	6.60	6.52
7	13.32	15.10	15.55	15.52	16.80	15.45	14.15	9.15	8.50	8.03	6.55	6.60
8	13.88	14.90	15.55	15.63	16.75	15.35	14.08	8.95	8.43	8.05	6.50	6.65
9	14.18	14.73	15.55	15.65	16.70	15.25	13.98	8.75	8.40	8.05	6.50	6.70
10	14.50	14.52	15.55	15.68	17.20	15.05	13.90	8.57	8.33	8.00	6.63	6.70
11	14.80	14.30	15.50	15.70	17.52	14.90	13.77	8.40	8.20	8.00	6.57	6.70
12	15.12	14.40	15.42	15.60	17.90	14.75	13.65	8.20	8.10	8.00	6.68	6.70
13	15.37	14.40	15.37	15.45	18.25	14.55	13.47	8.00	8.05	7.90	6.82	6.70
14	15.55	14.42	15.25	15.30	18.45	14.55	13.35	7.80	7.95	7.75	6.92	6.70
15	15.80	14.40	15.13	15.22	18.53	14.50	13.15	7.55	7.85	7.60	6.85	6.70
16	15.93	14.32	14.97	15.12	18.53	14.35	12.93	7.35	7.87	7.00	6.90	6.70
17	16.05	14.18	14.80	14.95	18.50	14.28	12.75	7.17	7.65	7.00	6.88	6.67
18	16.13	14.42	14.60	14.75	18.40	14.35	12.50	7.00	7.53	6.97	6.80	6.58
19	16.15	14.40	14.47	14.62	18.25	14.37	12.30	6.85	7.42	7.12	6.75	6.55
20	16.20	14.45	14.30	14.45	18.07	14.50	12.02	6.80	7.50	7.02	6.75	6.52
21	16.15	14.47	14.10	14.25	17.87	14.50	11.75	6.77	7.60	6.98	6.80	6.47
22	16.15	14.55	13.90	14.05	17.73	14.60	11.50	6.68	7.60	7.08	6.75	6.40
23	16.15	14.55	13.65	13.98	17.55	14.60	11.25	6.53	7.65	6.95	6.75	6.40
24	16.15	14.57	13.50	14.05	17.35	14.60	11.02	6.50	7.60	6.90	6.70	6.42
25	16.20	14.68	13.25	14.77	17.10	14.65	10.65	6.53	7.57	6.87	6.70	6.50
26	16.20	14.78	13.12	15.07	16.88	14.62	10.40	6.58	7.60	6.77	6.70	6.50
27	16.20	14.93	13.10	15.55	16.75	14.50	10.15	6.50	7.57	6.85	6.70	6.55
28	16.20	15.08	13.30	16.00	16.55	14.40	9.95	6.85	7.50	6.88	6.70	6.55
29	16.23	15.17	13.57	16.37	16.37	14.35	9.75	7.13	7.47	6.80	6.70	6.50
30	16.20	.....	13.90	16.67	16.43	14.32	9.55	7.40	7.40	6.70	6.70	6.45
31	16.20	.....	14.27	.....	16.43	.....	9.35	7.42	.....	6.68	.....	6.45
Monthly mean.	14.88	14.83	14.65	15.15	17.39	14.90	12.48	7.83	7.90	7.32	6.69	6.58

Gauge readings on the Illinois River below Copperas Creek Dam, Ill.—Continued.

[Readings are referred to lower miter-sill of lock, which is 5 feet below low water of 1873 and 1879.]

1881.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	6.45	6.70	16.72	19.97	19.50	12.48	13.95	7.60	6.20	6.52	12.58	18.25
2	6.50	6.65	17.08	19.88	19.30	12.12	13.65	7.60	6.33	6.90	12.67	18.12
3	6.50	6.70	17.70	19.68	19.10	11.80	13.32	7.65	6.40	7.25	12.75	18.10
4	6.45	6.75	18.00	19.48	18.90	11.45	13.02	7.65	6.37	7.40	12.75	18.65
5	6.45	6.78	18.27	19.25	18.70	11.10	12.72	7.65	6.22	7.55	12.70	18.00
6	6.45	6.80	18.60	19.05	18.50	10.97	12.20	7.65	6.08	7.73	12.75	17.87
7	6.45	7.58	18.80	18.80	18.25	11.37	11.87	7.57	6.13	7.78	12.75	17.85
8	6.40	9.37	18.90	18.63	18.05	12.20	11.50	7.62	6.27	7.87	12.80	17.77
9	6.40	10.90	18.95	18.53	17.85	12.85	11.00	7.42	6.30	8.08	12.80	17.65
10	6.40	12.58	18.95	18.50	17.65	13.50	10.52	7.40	6.30	8.18	12.80	17.62
11	6.40	13.22	19.10	18.55	17.40	13.90	10.15	7.35	6.37	8.20	13.12	17.52
12	6.40	14.05	19.40	18.70	17.20	14.35	9.72	7.30	6.22	8.27	13.75	17.40
13	6.40	14.50	19.65	18.95	17.05	14.72	9.27	7.25	6.07	8.50	14.30	17.43
14	6.40	14.80	19.87	19.15	16.85	15.10	9.68	7.23	6.12	8.77	14.95	17.55
15	6.40	15.13	20.10	19.35	16.65	15.47	10.23	7.18	6.27	9.10	15.55	17.75
16	6.40	15.30	20.40	19.75	16.45	15.75	10.55	7.08	6.30	9.50	15.23	18.10
17	6.40	15.45	20.60	19.95	16.25	15.83	9.93	7.05	6.30	10.00	16.77	18.50
18	6.40	15.60	20.87	20.12	16.05	15.82	9.75	6.97	6.15	10.40	17.43	18.85
19	6.40	15.85	21.10	20.30	15.85	15.80	9.35	6.82	6.18	10.90	17.93	19.05
20	6.40	15.97	21.27	20.52	15.65	15.72	8.92	6.80	6.33	11.25	18.25	19.22
21	6.50	16.10	21.37	20.75	15.45	15.60	8.60	6.80	6.30	11.48	18.38	19.33
22	6.50	16.17	21.32	20.88	15.25	15.45	8.25	6.75	6.27	11.55	18.62	19.42
23	6.50	16.25	21.08	20.85	15.05	15.25	7.97	6.67	6.18	11.63	18.72	19.58
24	6.50	16.23	20.75	20.77	14.85	15.05	7.75	6.65	6.17	11.75	18.80	19.80
25	6.55	16.17	20.55	20.65	14.65	14.85	7.55	6.60	6.07	11.82	18.80	20.28
26	6.55	16.18	20.38	20.50	14.40	14.60	7.58	6.48	6.15	11.95	18.77	20.73
27	6.60	16.35	20.27	20.32	14.12	14.40	7.60	6.40	6.13	12.02	18.62	21.03
28	6.60	16.52	20.17	20.15	13.87	14.43	7.63	6.40	6.27	12.13	18.57	21.15
29	6.65	.....	20.08	19.95	13.52	14.32	7.65	6.35	6.16	12.30	18.45	21.15
30	6.65	.....	20.05	19.75	13.22	14.17	7.60	6.25	5.90	12.48	16.33	21.08
31	6.70	.....	20.05	.....	13.05	.....	7.57	6.18	.....	12.55	.....	20.95
Monthly mean	6.48	12.88	19.69	19.72	16.41	14.01	9.89	7.04	6.22	9.74	15.69	18.88

1882.

1	20.75	15.08	17.00	18.62	17.45	18.45	20.15	13.22	9.50	7.42	8.40	9.38
2	20.45	14.90	17.35	18.53	17.50	18.45	20.00	12.95	9.90	7.42	8.48	9.30
3	20.20	14.85	17.70	18.47	17.50	18.65	19.70	12.67	10.15	7.60	8.55	9.27
4	19.95	14.82	18.17	18.42	17.40	18.80	19.35	12.45	10.38	7.80	8.60	9.17
5	19.55	14.68	18.60	18.27	17.43	18.90	19.15	12.27	10.48	7.82	8.60	9.10
6	19.20	14.50	18.87	18.12	17.50	19.18	18.87	12.22	10.50	7.77	8.55	9.10
7	18.95	14.35	19.07	17.98	17.55	19.35	18.60	12.25	10.42	7.80	8.55	9.07
8	18.63	14.27	19.15	17.77	17.67	19.38	18.32	12.22	10.40	7.80	8.48	9.05
9	18.50	14.17	19.20	17.75	17.70	19.35	18.12	12.10	10.35	7.88	8.45	9.00
10	18.27	14.07	19.25	17.70	17.70	19.37	18.00	12.02	10.15	8.05	8.60	8.92
11	18.10	13.97	19.23	17.57	17.70	19.65	17.80	12.00	9.95	8.20	8.75	8.87
12	17.92	13.82	19.25	17.55	17.80	19.97	17.60	11.92	9.75	8.25	8.90	8.80
13	17.80	13.80	19.25	17.55	18.22	20.35	17.40	11.78	9.52	8.33	9.12	8.75
14	17.63	13.80	19.20	17.48	18.52	20.68	17.17	11.65	9.30	8.35	9.23	8.72
15	17.50	13.85	19.10	17.40	18.73	20.65	16.90	11.52	9.15	8.47	9.38	8.65
16	17.30	13.90	19.02	17.38	18.85	20.58	16.62	11.42	9.02	8.60	9.43	8.60
17	17.05	13.93	18.92	17.27	18.78	20.63	16.37	11.25	8.85	8.73	9.57	8.60
18	16.87	13.95	18.90	17.17	18.62	20.60	16.15	11.05	8.72	8.80	9.68	8.60
19	16.70	14.08	18.92	17.05	18.40	20.45	15.95	10.75	8.55	8.80	9.75	8.60
20	16.53	14.25	19.07	16.95	18.25	20.20	15.75	10.55	8.37	8.80	9.80	8.82
21	16.40	14.50	19.27	16.75	18.10	19.95	15.50	10.39	8.32	8.77	9.87	9.67
22	16.27	14.75	19.30	16.62	17.90	19.70	15.30	10.03	8.17	8.78	9.90	10.68
23	16.13	14.95	19.25	16.65	17.70	19.60	15.05	9.75	8.05	8.73	9.85	11.27
24	16.03	15.17	19.25	16.65	17.52	19.40	14.85	9.65	7.97	8.73	9.85	11.72
25	15.93	15.60	19.20	16.60	17.40	19.17	14.55	9.68	7.88	8.65	9.82	12.10
26	15.83	16.10	19.13	16.63	17.20	19.15	14.30	9.52	7.80	8.62	9.80	12.32
27	15.67	16.35	19.02	16.78	17.48	19.25	14.05	9.55	7.72	8.53	9.80	12.48
28	15.52	16.70	18.90	16.90	17.72	19.50	13.85	9.42	7.62	8.45	9.73	12.70
29	15.45	.....	18.85	17.10	18.10	19.95	13.55	9.35	7.52	8.40	9.65	12.90
30	15.37	.....	18.77	17.10	18.35	20.08	13.28	9.25	7.47	8.35	9.53	13.13
31	15.23	.....	18.70	.....	18.55	.....	13.53	9.35	.....	8.40	.....	13.28
Monthly mean	17.47	14.61	18.87	17.43	17.91	19.65	16.64	11.10	9.06	8.29	9.22	10.08

Gauge readings on the Illinois River below Copperas Creek dam, Ill.—Continued.

[Readings are referred to lower miter-sill of lock, which is 5 feet below water of 1873 and 1879.]

1883.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	13.45	9.08	23.32	16.67	17.17	16.73	16.35	14.33	7.50	6.90	9.63	16.02
2	13.55	9.00	23.05	16.55	17.00	16.70	16.20	14.27	7.48	7.13	9.80	16.08
3	13.50	9.08	22.80	16.37	16.80	16.68	16.00	14.23	7.52	7.20	9.95	16.05
4	13.37	9.10	22.70	16.22	16.67	16.60	15.82	14.12	7.48	7.22	10.05	16.00
5	13.27	9.00	22.75	16.30	16.50	16.52	15.72	14.00	7.45	7.50	10.22	15.98
6	13.17	8.87	22.70	16.45	16.30	16.42	15.55	13.80	7.35	7.60	10.62	15.90
7	13.07	8.83	22.45	16.80	16.22	16.30	15.42	13.60	7.22	7.65	11.30	15.75
8	12.98	8.80	22.12	17.10	16.10	16.17	15.30	13.35	7.17	7.55	11.90	15.68
9	12.85	9.05	21.75	17.50	16.02	16.25	15.10	13.15	7.15	7.45	12.55	15.58
10	12.67	9.25	21.45	17.83	16.02	16.15	14.95	12.90	7.07	7.50	13.00	15.48
11	12.52	9.52	21.15	18.10	16.18	16.15	14.75	12.60	6.92	7.57	13.52	15.38
12	12.42	9.85	20.85	18.23	16.30	16.20	14.55	12.27	6.80	7.55	13.90	15.25
13	12.30	10.37	20.60	18.42	16.55	16.20	14.42	11.98	6.72	7.63	14.18	15.08
14	12.12	11.08	20.30	18.45	16.85	16.23	14.32	11.57	6.65	7.65	14.35	14.98
15	11.95	12.17	19.93	18.42	17.13	16.30	14.10	11.17	6.55	7.55	14.52	14.80
16	11.70	14.27	19.67	18.35	17.32	16.43	13.98	10.77	6.60	7.45	14.60	14.68
17	11.50	15.77	19.38	18.30	17.45	16.60	14.00	10.35	6.73	7.50	14.60	14.60
18	11.30	17.12	19.07	18.30	17.48	16.75	13.90	9.87	6.73	7.57	14.60	14.55
19	11.13	19.28	18.88	18.22	17.58	16.78	13.70	9.45	6.57	7.55	14.55	14.28
20	10.95	21.17	18.78	18.10	17.53	16.80	13.62	9.20	7.15	7.63	14.55	14.03
21	10.83	22.55	18.75	17.95	17.55	16.90	13.45	8.87	7.00	8.40	14.58	13.92
22	10.65	23.40	18.52	17.75	17.53	17.00	13.32	8.75	6.90	8.45	14.67	13.70
23	10.47	23.80	18.25	17.73	17.40	17.00	13.23	8.50	6.80	8.50	14.72	13.65
24	10.32	24.05	17.95	17.85	17.22	17.00	13.15	8.37	6.60	8.52	14.87	13.80
25	10.10	24.25	17.78	17.93	17.02	16.92	16.13	8.15	6.60	8.60	15.03	13.75
26	9.90	24.05	17.65	17.90	16.90	16.83	13.30	8.00	6.65	8.60	15.23	13.52
27	9.67	23.90	17.52	17.75	16.72	16.80	13.60	7.85	6.65	8.60	15.50	13.38
28	9.53	23.63	17.40	17.65	16.70	16.72	13.87	7.67	6.75	8.73	15.68	13.17
29	9.38	.....	17.15	17.52	16.65	16.60	14.08	7.60	6.70	8.93	15.83	12.93
30	9.27	.....	16.98	17.35	16.72	16.52	14.23	7.55	6.85	9.12	15.97	12.85
31	9.18	.....	16.80	.....	16.77	.....	14.23	7.53	.....	9.35	.....	12.73
Monthly Mean	11.58	15.01	19.95	17.60	16.85	16.57	14.43	10.83	6.94	7.91	13.48	14.63

1884.

1	12.63	11.72	19.62	21.50	16.28	13.65	11.93	10.22	7.87	9.85	11.95	10.77
2	12.45	12.30	19.40	21.43	16.18	13.50	11.80	10.10	7.62	10.13	11.80	10.65
3	12.40	12.73	19.15	21.28	16.02	13.53	11.68	10.20	7.50	10.53	11.67	10.43
4	12.40	13.15	18.95	21.10	15.92	13.40	11.45	10.20	7.45	10.78	11.58	10.33
5	12.35	13.92	18.70	20.82	15.82	13.27	11.48	10.20	7.40	11.00	11.50	10.30
6	12.35	14.30	18.52	20.52	15.88	13.25	11.42	10.17	7.28	11.08	11.53	10.42
7	12.35	14.68	18.30	20.25	15.97	13.08	11.25	10.07	7.40	11.70	11.55	10.80
8	12.35	15.00	18.10	20.00	16.02	13.00	10.98	9.95	7.43	12.67	11.60	11.38
9	12.28	15.40	17.90	19.68	16.05	13.15	10.75	9.75	7.38	13.35	11.60	11.77
10	12.23	15.75	17.68	19.35	16.05	13.10	10.73	9.60	7.35	13.95	11.63	12.10
11	12.15	16.15	17.55	19.10	16.05	12.95	11.17	9.43	7.35	14.40	11.60	12.32
12	12.08	16.62	17.42	18.90	16.05	12.83	11.75	9.23	7.30	14.70	11.57	12.52
13	11.98	17.17	17.30	18.65	16.08	12.65	12.25	9.05	7.18	14.75	11.45	12.58
14	11.90	17.52	17.15	18.40	16.15	12.45	12.45	8.85	7.05	14.72	11.33	12.60
15	11.83	17.82	17.05	18.20	16.15	12.25	12.50	8.53	6.90	14.63	11.23	12.60
16	11.73	18.10	17.00	18.00	16.05	12.07	12.45	8.27	6.83	14.53	11.08	12.58
17	11.63	18.38	17.00	17.80	15.98	11.95	12.35	7.93	6.90	14.37	10.93	12.75
18	11.53	18.68	17.12	17.65	15.88	11.85	12.25	7.53	6.85	14.20	10.80	12.60
19	11.43	19.07	17.28	17.53	15.80	11.90	12.08	7.30	6.75	13.98	10.65	12.42
20	11.33	19.42	17.45	17.47	15.67	11.97	11.85	7.15	6.80	13.80	10.40	12.33
21	11.25	19.77	17.70	17.38	15.57	12.05	11.60	7.15	6.70	13.60	10.27	12.23
22	11.08	20.08	18.02	17.30	15.45	12.15	11.30	7.08	6.83	13.45	10.20	12.13
23	10.93	20.27	18.37	17.25	15.33	12.10	11.00	6.95	8.12	13.25	10.78	12.02
24	10.78	20.40	18.72	17.12	15.15	12.17	11.80	6.88	9.52	13.03	11.05	11.93
25	10.63	20.45	19.07	17.05	14.97	12.18	10.65	6.73	9.85	12.87	11.20	11.82
26	10.53	20.45	19.57	16.87	14.80	12.17	10.52	6.73	9.83	12.75	11.25	11.73
27	10.38	20.38	20.07	16.75	14.65	12.20	10.55	6.75	9.80	12.58	11.25	11.63
28	10.28	20.20	20.58	16.55	14.45	12.18	10.55	7.23	9.83	12.43	11.18	11.65
29	10.23	19.88	21.12	16.40	14.30	12.15	10.48	7.75	9.85	12.33	11.08	12.12
30	10.37	.....	21.38	16.25	14.10	12.05	10.43	8.15	9.80	12.23	10.92	13.32
31	11.15	.....	21.48	.....	13.88	.....	10.33	7.95	.....	12.08	.....	14.40
Monthly mean	11.58	17.23	18.54	18.55	15.57	12.57	11.41	8.49	7.82	12.89	11.22	11.91

Gauge readings on the Illinois River below Copperas Creek Dam, Ill.—Continued.

[Readings are referred to lower miter sill of lock, which is 5 feet below low water of 1873, 1879, and 1885.]

1885.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	15.12	16.83	13.58	18.20	18.97	13.18	10.82	9.65	10.97	11.43	13.87	14.90
2	15.65	16.73	13.52	18.28	18.85	13.05	10.67	9.70	10.83	11.47	13.85	14.67
3	16.40	16.63	13.65	18.32	18.65	12.98	10.50	9.87	10.75	11.30	13.80	14.47
4	17.10	16.50	13.95	18.42	18.40	12.95	10.37	9.95	10.58	11.20	13.97	14.40
5	17.68	16.38	14.42	18.47	18.20	13.00	10.23	10.03	10.50	11.10	14.03	14.40
6	18.30	16.28	14.92	18.50	18.03	13.05	10.05	10.32	10.45	11.15	14.20	14.30
7	18.95	16.20	15.32	18.55	17.85	13.05	9.88	10.75	10.28	11.10	14.40	14.23
8	19.35	16.13	15.65	18.55	17.67	13.10	9.63	10.78	10.43	10.97	14.77	14.03
9	19.62	16.03	16.03	18.55	17.45	13.10	9.43	10.80	10.23	11.00	14.87	14.00
10	19.68	15.93	16.68	18.53	17.25	13.07	9.50	10.82	10.10	11.25	15.05	13.93
11	19.77	15.78	16.90	18.48	17.05	12.97	9.85	10.80	10.17	11.23	15.53	13.90
12	19.85	15.68	17.17	18.40	16.93	12.88	10.33	10.72	10.43	11.32	15.78	13.90
13	19.60	15.55	17.50	18.30	16.75	12.90	10.98	10.57	10.93	11.30	15.90	13.87
14	19.35	15.42	17.90	18.20	16.65	12.88	11.27	10.53	11.17	11.22	15.93	13.80
15	19.15	15.33	18.32	18.08	16.35	12.83	11.03	10.37	11.32	11.07	16.17	13.80
16	18.95	15.20	18.77	17.98	16.13	12.73	10.85	9.93	11.27	10.97	16.23	13.70
17	18.83	15.08	19.08	18.12	15.93	12.55	10.58	9.47	11.40	10.88	16.07	13.60
18	18.65	14.95	19.27	18.25	15.75	12.30	10.35	9.42	11.53	10.82	16.23	13.50
19	18.45	14.83	19.32	18.40	15.55	12.05	10.05	9.38	11.73	10.85	16.17	13.40
20	18.32	14.70	19.40	18.62	15.38	11.88	9.72	9.23	11.68	10.97	16.17	13.40
21	18.15	14.53	19.37	18.87	15.20	11.78	9.42	9.03	11.87	10.97	16.03	13.40
22	17.98	14.38	19.30	19.05	15.00	11.78	9.18	8.90	11.73	11.38	16.03	13.43
23	17.88	14.25	19.20	19.25	14.80	11.68	9.08	8.63	11.42	11.72	16.00	13.60
24	17.78	14.13	19.03	19.43	14.60	11.55	9.02	8.53	11.37	12.37	15.83	13.83
25	17.68	14.03	18.90	19.55	14.40	11.40	8.82	9.03	11.35	12.78	15.62	13.70
26	17.50	13.87	18.70	19.63	14.17	11.28	9.13	9.52	11.40	12.92	15.50	13.87
27	17.43	13.78	18.50	19.60	13.93	11.13	8.97	10.30	11.32	13.13	15.43	14.15
28	17.33	13.68	18.32	19.50	13.65	11.07	9.38	10.87	11.43	13.43	15.35	14.43
29	17.23	.....	18.25	19.38	13.50	11.03	9.22	11.17	11.57	13.63	15.20	14.77
30	17.08	.....	18.23	19.20	13.35	10.93	9.13	11.10	11.53	13.67	15.07	15.05
31	16.98	.....	18.20	.....	13.22	.....	9.53	11.10	.....	13.63	.....	15.60
Monthly mean	18.12	15.31	17.33	18.69	16.12	12.34	9.90	10.04	11.06	11.68	15.30	14.07

1886.

1	15.98	16.55	16.63	18.85	16.93	17.30	10.55	6.65	6.72	8.08	8.22	7.70
2	16.35	16.40	19.50	18.70	16.73	17.10	10.30	6.60	6.73	8.12	8.12	7.70
3	16.68	16.25	19.30	18.50	16.60	16.88	10.02	6.58	6.75	8.20	8.10	7.67
4	16.90	16.10	19.18	18.33	16.58	16.65	9.73	6.50	6.75	8.27	8.05	7.60
5	17.23	15.95	19.00	18.20	16.60	16.40	9.37	6.50	6.72	8.42	8.00	7.60
6	17.55	15.80	18.80	18.10	16.58	16.05	9.08	6.50	6.72	8.42	8.07	7.65
7	17.78	15.60	18.60	18.10	16.58	15.85	8.90	6.50	6.82	8.40	8.13	7.77
8	18.05	15.43	18.42	18.05	16.48	15.60	8.60	6.50	6.83	8.33	8.18	7.85
9	18.12	15.33	18.25	17.85	16.40	15.30	8.32	6.48	6.90	8.23	8.20	7.83
10	18.10	15.35	18.10	17.80	16.40	15.00	8.20	6.40	6.90	8.13	8.23	7.85
11	18.03	15.57	17.92	17.80	16.40	14.75	8.05	6.35	6.82	8.10	8.17	7.90
12	17.95	15.97	17.75	17.82	16.42	14.48	7.85	6.30	6.85	8.03	8.05	7.93
13	17.78	16.30	17.55	17.65	16.40	14.25	7.75	6.57	6.85	7.93	7.87	7.90
14	17.70	16.68	17.42	17.58	16.53	13.98	7.62	7.15	6.90	7.62	7.83	7.87
15	17.65	16.98	17.33	17.50	16.70	13.77	7.53	7.33	6.92	7.65	7.80	7.73
16	17.60	17.53	17.22	17.67	17.00	13.63	7.42	7.40	6.97	7.70	7.83	7.65
17	17.55	18.23	17.12	17.62	17.35	13.53	7.35	7.40	7.22	7.75	7.78	7.60
18	17.50	19.00	17.22	17.75	17.80	13.37	7.20	7.27	7.30	7.83	7.50	7.60
19	17.45	19.60	17.15	17.92	18.15	13.10	7.08	7.05	7.30	7.90	7.47	7.60
20	17.38	19.80	17.25	18.00	18.40	12.85	7.02	6.90	7.32	7.90	7.60	7.60
21	17.25	20.08	17.40	18.05	18.60	12.58	7.00	6.83	7.40	7.90	7.70	7.55
22	17.15	20.15	17.68	18.00	18.72	12.37	7.00	6.65	7.52	7.95	7.77	7.55
23	17.10	20.15	18.13	17.93	18.70	12.20	7.00	6.80	7.62	8.00	7.82	7.58
24	17.03	20.10	18.62	17.73	18.70	11.90	6.97	6.90	7.65	8.17	7.80	7.65
25	16.95	20.10	18.98	17.68	18.60	11.62	6.95	6.90	7.68	8.45	7.88	7.60
26	16.83	20.10	19.20	17.63	18.42	11.50	6.90	6.90	7.95	8.63	7.87	7.60
27	16.75	19.95	19.30	17.45	18.32	11.37	6.80	6.88	8.18	8.52	7.85	7.53
28	16.87	19.75	19.18	17.25	18.13	11.10	6.75	6.80	8.32	8.45	7.88	7.53
29	16.85	.....	19.13	17.10	17.95	10.85	6.70	6.80	8.32	8.37	7.90	7.50
30	16.80	.....	19.02	17.00	17.75	10.70	6.70	6.88	8.18	8.30	7.78	7.55
31	16.70	.....	18.95	.....	17.48	.....	6.70	6.85	.....	8.27	.....	7.55
Monthly mean	17.28	17.67	18.24	17.85	17.37	13.87	7.85	6.78	7.24	8.13	7.91	7.67

Gauge-readings on the Illinois River below Copperas Creek Dam, Ill.—Continued.

[Readings are referred to lower miter-sill of lock, which is 5 feet below low water of 1873 and 1879.]

1887.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	7.55	14.20	19.55	15.42	10.50	7.20	6.90	6.00	6.65	7.20	7.40	7.15
2	7.55	14.20	19.30	15.23	10.40	7.15	6.90	6.00	6.65	7.10	7.40	7.20
3	7.60	14.20	18.87	15.07	10.37	7.10	6.90	6.00	6.70	7.07	7.30	7.35
4	7.60	14.20	18.43	14.90	10.20	7.10	7.02	6.00	6.70	7.00	7.25	7.80
5	7.65	14.20	18.23	14.60	10.00	7.10	7.10	6.00	6.70	7.00	7.20	7.92
6	7.65	14.20	18.00	14.38	10.07	7.30	7.10	6.00	6.75	7.08	7.20	8.10
7	7.65	14.33	17.83	14.22	9.98	7.45	7.10	6.00	6.78	7.10	7.20	8.18
8	7.65	14.62	17.83	13.97	9.90	7.45	7.07	6.00	6.80	7.15	7.20	8.32
9	7.70	14.93	17.80	13.67	9.75	7.50	7.00	6.00	6.80	7.38	7.20	8.42
10	7.75	15.63	17.80	13.37	9.58	7.62	7.00	6.10	6.80	7.60	7.15	8.50
11	7.82	16.97	17.80	13.20	9.43	7.65	6.90	6.20	6.80	7.60	7.10	8.55
12	7.90	18.10	17.87	13.20	9.27	7.78	6.90	6.28	6.80	7.50	7.10	8.57
13	7.90	19.07	17.90	13.23	9.17	7.80	6.78	6.30	6.80	7.50	7.10	8.60
14	7.95	19.37	17.87	13.25	9.10	7.80	6.75	6.40	6.80	7.50	7.00	8.63
15	7.95	19.83	17.80	13.20	9.05	7.75	6.68	6.45	6.80	7.48	7.00	8.70
16	7.95	20.20	17.78	12.97	8.98	7.70	6.65	6.60	6.80	7.50	7.00	8.73
17	8.00	20.33	17.73	12.60	8.90	7.70	6.60	6.67	6.70	7.55	6.90	8.75
18	8.02	20.50	17.62	12.45	8.75	7.70	6.60	6.73	6.70	7.50	6.90	8.80
19	8.05	20.80	17.53	12.07	8.57	7.70	6.57	6.72	6.70	7.50	6.90	8.83
20	8.60	21.00	17.50	11.90	8.35	7.60	6.50	6.67	6.75	7.50	6.90	8.85
21	9.13	21.17	17.42	11.77	8.17	7.50	6.47	6.70	6.75	7.50	6.90	8.90
22	9.87	21.25	17.27	11.58	8.05	7.43	6.40	6.70	6.85	7.50	6.90	8.85
23	10.33	20.97	16.93	11.33	8.00	7.32	6.33	6.67	6.90	7.55	6.90	8.80
24	10.63	20.80	16.77	11.15	7.90	7.23	6.28	6.65	6.90	7.50	6.95	8.80
25	11.00	20.50	16.55	10.93	7.75	7.10	6.20	6.60	6.90	7.50	7.00	8.83
26	12.10	20.17	16.40	10.77	7.58	7.10	6.18	6.60	6.90	7.50	7.07	8.85
27	12.73	19.95	16.25	10.70	7.52	7.10	6.10	6.60	7.00	7.40	7.10	8.90
28	13.50	19.77	16.10	10.68	7.45	7.05	6.10	6.60	7.25	7.40	7.15	8.90
29	13.83	.....	15.95	10.60	7.40	7.00	6.07	6.65	7.30	7.45	7.15	8.87
30	14.07	.....	15.77	10.60	7.37	6.93	6.10	6.70	7.25	7.42	7.15	8.80
31	14.20	.....	15.58	.....	7.28	.....	6.00	6.70	.....	7.40	.....	8.80
Monthly mean.	9.29	18.05	17.48	12.77	8.86	7.40	6.62	6.40	6.83	7.38	7.09	8.49

1888.

1	8.80	11.02	16.90	18.70	13.80	16.00	12.10	11.60	7.43	6.47	7.03	7.60
2	8.75	11.00	17.37	18.82	13.53	16.47	12.22	11.10	7.40	6.50	7.05	7.60
3	8.75	11.00	17.73	18.75	13.40	16.73	12.23	10.80	7.30	6.50	7.15	7.60
4	8.75	10.90	18.07	18.70	13.23	16.97	12.20	10.40	7.20	6.50	7.23	7.55
5	8.75	10.80	18.43	18.60	13.07	17.03	12.40	10.10	7.18	6.55	7.30	7.50
6	9.48	10.80	18.40	18.33	12.87	17.03	12.50	9.80	7.07	6.72	7.32	7.50
7	11.47	10.73	18.37	18.10	12.63	17.00	12.53	9.53	6.98	6.80	7.42	7.60
8	11.70	10.70	18.20	17.97	12.23	17.00	12.62	9.40	6.85	6.80	7.67	7.60
9	11.93	10.70	18.20	17.80	12.27	16.90	13.37	9.28	6.80	6.80	7.93	7.60
10	11.98	10.60	18.13	17.63	12.43	16.72	13.90	9.07	6.80	6.75	8.12	7.60
11	12.10	10.60	18.03	17.50	12.50	16.53	14.10	8.97	6.80	6.70	8.43	7.60
12	12.13	10.50	17.90	17.42	12.50	16.33	14.15	8.90	6.80	6.70	8.57	7.50
13	12.37	10.83	17.90	17.22	12.50	16.10	14.32	8.80	6.80	6.70	8.60	7.43
14	12.57	11.10	17.90	17.10	12.57	15.73	14.40	8.72	6.75	6.70	8.50	7.40
15	12.65	11.53	17.82	17.00	12.50	15.57	14.40	8.70	6.75	6.73	8.45	7.35
16	12.70	11.87	17.72	16.90	12.35	15.22	14.50	8.75	6.65	6.75	8.40	7.30
17	12.75	12.17	17.60	16.70	12.30	14.93	14.50	8.75	6.60	6.80	8.32	7.40
18	12.75	12.30	17.57	16.40	12.30	14.75	14.40	8.70	6.68	6.87	8.20	7.45
19	12.78	12.65	17.60	16.17	12.30	14.50	14.35	8.83	6.70	7.20	8.13	7.60
20	12.80	13.00	17.50	16.07	12.20	14.13	14.13	8.90	6.72	7.37	8.05	7.58
21	12.80	13.57	17.50	15.93	11.97	14.07	13.97	8.83	6.80	7.45	7.92	7.50
22	12.75	14.20	17.57	15.85	12.00	14.00	13.78	8.73	6.95	7.38	7.90	7.50
23	12.60	14.50	17.57	15.77	11.83	13.93	13.63	8.55	7.07	7.37	7.90	7.50
24	12.33	15.00	17.60	15.60	11.80	13.87	13.50	8.50	7.05	7.40	7.82	7.50
25	12.00	15.70	17.50	15.30	11.90	13.60	13.23	8.50	7.00	7.40	7.80	7.50
26	11.63	15.80	17.60	14.97	12.03	13.43	13.00	8.45	6.73	7.20	7.75	7.55
27	11.37	15.70	17.77	14.43	12.90	13.20	12.93	8.25	6.57	7.05	7.70	7.77
28	11.20	16.00	17.93	14.40	13.73	12.80	12.80	8.15	6.47	7.00	7.70	7.85
29	11.10	16.50	18.33	14.27	14.62	12.53	12.40	8.02	6.47	7.05	7.65	7.92
30	11.10	.....	18.57	14.00	15.17	12.20	12.18	7.83	6.40	7.10	7.62	8.03
31	11.05	.....	18.70	.....	15.63	.....	11.90	7.65	.....	7.05	.....	8.22
Monthly mean	11.48	12.47	17.87	16.75	12.81	15.18	13.31	9.05	6.86	6.91	7.85	7.59

Gauge-readings on the Illinois River below Copperas Creek Dam, Ill.—Continued.

[Readings are referred to lower miter-sill of lock, which is 65 feet below low water of 1873 and 1879.]

1889.

Day.	Jan.	Feb.	Mar.	April	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	8.25	9.97	9.50	11.10	11.17	9.17	15.75	12.10	7.40	7.78	8.05	8.88
2	8.20	9.77	10.60	11.03	10.80	9.35	15.53	11.82	7.42	7.70	8.55	8.85
3	8.28	9.55	11.27	10.98	10.50	9.70	15.42	11.65	7.40	7.70	8.68	8.88
4	8.35	9.37	11.40	10.90	10.10	10.03	15.32	11.52	7.40	7.70	8.78	8.80
5	8.43	9.27	11.70	10.80	9.87	10.53	15.10	11.33	7.47	7.60	8.90	8.72
6	8.40	9.10	12.20	10.80	9.67	11.00	15.00	11.22	7.65	7.65	8.90	8.85
7	8.43	9.00	12.57	10.80	9.45	11.20	14.90	11.07	7.80	7.57	8.92	9.10
8	8.47	8.90	12.73	10.80	9.22	12.66	14.67	10.88	7.90	7.50	9.12	9.35
9	8.50	8.90	12.97	10.80	8.93	13.82	14.30	10.68	8.02	7.40	9.27	9.55
10	8.45	8.90	13.10	10.80	8.72	14.05	14.00	10.55	8.25	7.28	9.40	10.20
11	8.37	8.77	13.13	10.72	8.55	14.17	13.85	10.33	8.55	7.20	9.40	10.70
12	8.45	8.63	13.03	10.60	8.40	14.25	13.65	10.20	8.77	7.20	9.40	10.93
13	8.60	8.53	13.20	10.63	8.48	14.20	13.55	10.03	8.90	7.25	9.32	11.20
14	8.83	8.40	13.10	10.70	8.40	14.10	13.30	9.85	9.00	7.45	9.30	11.60
15	8.97	8.13	13.10	10.77	8.40	14.10	13.07	9.70	9.15	7.55	9.22	11.80
16	9.20	8.00	12.93	10.77	8.33	14.32	12.93	9.50	9.20	7.60	9.20	11.88
17	9.60	8.00	12.90	10.70	8.30	14.53	13.13	9.25	9.10	7.53	9.27	12.02
18	10.30	8.00	12.85	10.77	8.25	14.68	13.30	9.12	9.03	7.42	9.35	12.18
19	10.55	8.13	12.70	11.50	8.20	14.82	13.43	8.95	9.00	7.35	9.40	12.23
20	10.73	8.30	12.62	11.83	8.30	15.08	13.60	8.75	8.85	7.30	9.32	12.30
21	11.10	8.43	12.48	12.03	8.38	15.27	13.60	8.45	8.70	7.30	9.25	12.30
22	11.00	8.65	12.35	12.10	8.43	15.53	13.50	8.10	8.60	7.30	9.22	12.37
23	11.00	8.90	12.22	12.15	8.27	15.77	13.33	7.82	8.60	7.30	9.20	12.35
24	10.83	9.15	12.13	12.10	8.27	15.85	13.30	7.65	8.47	7.35	9.20	12.30
25	10.73	9.20	12.05	12.03	8.33	15.93	13.20	7.53	8.33	7.40	9.15	12.28
26	10.70	9.20	11.85	12.00	8.40	15.98	13.05	7.50	8.22	7.40	9.10	12.23
27	10.70	9.20	11.72	11.90	8.33	16.08	13.00	7.45	8.12	7.45	9.10	12.15
28	10.65	9.20	11.50	11.83	8.22	16.20	12.97	7.45	8.02	7.50	9.10	12.10
29	10.53	.....	11.37	11.68	8.70	16.02	12.85	7.42	7.93	7.50	9.05	12.00
30	10.37	.....	11.23	11.50	8.95	15.93	12.65	7.40	7.90	7.50	8.93	12.00
31	10.15	.....	11.20	.....	9.05	.....	12.40	7.40	.....	7.75	.....	11.92
Monthly mean	9.52	8.84	12.18	11.24	8.88	13.81	13.80	9.44	8.30	7.47	9.10	11.03

MONTHLY MEANS.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly mean.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1879	7.76	11.20	13.66	15.80	10.52	7.66	9.53	7.09	5.30	6.03	7.19	10.24	9.33
1880	14.88	14.83	14.65	15.15	17.39	14.90	12.48	7.83	7.90	7.32	6.69	6.58	11.72
1881	6.48	12.88	19.69	19.72	16.41	14.01	9.89	7.04	6.22	9.74	15.69	18.88	13.05
1882	17.47	14.61	18.87	17.43	17.91	19.65	16.64	11.10	9.06	8.29	9.22	10.08	14.19
1883	11.58	15.01	19.95	17.60	16.85	16.57	14.43	10.83	6.94	7.91	13.48	14.63	13.82
1884	11.58	17.23	18.54	18.55	15.57	12.57	11.41	8.49	7.82	12.89	11.22	11.91	13.15
1885	18.12	15.31	17.33	18.69	16.12	12.34	9.90	10.04	11.06	11.68	15.30	14.07	14.16
1886	17.28	17.67	18.24	17.85	17.37	13.87	7.85	6.78	7.24	8.13	7.91	7.67	12.32
1887	9.29	18.05	17.48	12.77	8.86	7.40	6.62	6.40	6.83	7.38	7.09	8.49	9.72
1888	11.48	12.47	17.87	16.75	12.81	15.18	13.31	9.05	6.86	6.91	7.85	7.59	11.51
1889	9.52	8.84	12.18	11.24	8.88	13.81	13.80	9.44	8.30	7.47	9.10	11.03	10.30
Mean for 11 years	12.31	14.37	17.15	16.50	14.43	13.45	11.44	8.55	7.58	8.52	10.07	11.01	12.11

Gauge readings on the Illinois River at La Grange, Ill.

[Readings are referred to low water of 1879.]

1883.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	8.17	4.60	20.90	12.57	13.35	12.35	13.80	8.30	2.40	1.40	3.40	9.40
2	8.45	4.48	20.63	12.35	13.25	12.30	13.50	8.30	2.30	1.40	3.60	9.60
3	8.73	4.60	20.40	12.10	13.12	12.25	13.20	8.30	2.20	1.50	3.70	9.80
4	8.87	4.60	20.00	11.85	12.95	12.20	12.90	8.20	2.10	1.60	4.00	10.00
5	8.90	4.55	19.80	11.67	12.80	12.10	12.60	8.15	2.00	2.20	4.15	10.15
6	8.98	4.50	19.60	11.63	12.60	12.05	12.30	7.85	1.90	2.50	4.80	10.25
7	9.05	4.55	19.40	11.93	12.40	12.00	11.95	7.75	2.00	2.50	5.90	10.40
8	9.08	4.68	19.10	12.00	12.20	11.90	11.70	7.60	2.00	2.50	6.30	10.30
9	8.98	4.65	18.83	12.05	12.00	11.90	11.35	7.50	2.00	2.40	6.40	10.20
10	8.80	4.87	18.47	12.03	11.80	11.95	11.00	7.40	1.95	2.35	6.40	10.10
11	8.58	5.25	18.18	12.12	11.60	11.90	10.75	7.30	1.80	2.30	6.50	10.00
12	8.47	5.65	17.87	12.27	11.43	12.10	10.50	7.10	1.70	2.30	6.65	9.85
13	8.38	6.57	17.55	12.45	11.35	12.25	10.25	6.90	1.60	2.30	6.80	9.70
14	8.15	8.33	17.28	12.70	11.42	12.35	10.00	6.60	1.50	2.30	7.00	9.60
15	8.02	10.27	16.95	12.88	11.55	12.40	9.85	6.30	1.40	2.20	7.10	9.40
16	7.80	11.77	16.58	12.95	11.58	12.60	9.72	6.00	1.40	2.20	7.30	9.30
17	7.63	13.47	16.35	13.12	11.65	12.90	9.97	5.70	1.40	2.30	7.60	9.10
18	7.48	14.43	16.15	13.18	11.75	13.30	10.08	5.20	1.40	2.30	7.70	9.00
19	7.28	16.57	15.72	13.25	11.85	13.50	9.92	4.40	1.40	2.50	7.75	8.90
20	6.98	19.93	15.40	13.32	11.95	13.50	9.60	4.10	1.30	3.00	7.90	8.40
21	6.75	20.20	15.13	13.35	12.05	13.85	9.28	4.00	1.30	3.10	7.95	7.90
22	6.55	20.90	14.85	13.37	12.05	14.20	9.10	3.90	1.40	3.15	8.20	7.70
23	6.35	21.33	14.57	13.57	12.10	14.45	9.00	3.70	1.40	3.10	8.40	7.30
24	6.12	21.50	14.32	13.60	12.30	14.60	8.90	3.50	1.50	3.00	8.45	7.20
25	5.95	21.82	14.08	13.55	12.30	14.70	8.70	3.40	1.50	3.00	8.45	7.10
26	5.72	21.72	13.80	13.48	12.45	14.60	8.60	3.10	1.50	3.00	8.55	7.00
27	5.52	.....	13.60	13.45	12.40	14.50	8.50	3.00	1.40	3.05	8.70	7.00
28	5.25	20.90	13.40	13.48	12.35	14.30	8.40	2.90	1.40	3.10	8.85	7.10
29	5.10	.....	13.20	13.50	12.35	14.15	8.40	2.70	1.40	3.15	9.00	7.20
30	4.98	.....	12.98	13.45	12.35	14.00	8.35	2.60	1.40	3.20	9.20	7.10
31	4.78	.....	12.80	.....	12.35	.....	8.30	2.50	.....	3.30	.....	7.10
Mean	7.41	11.36	16.71	12.77	12.18	13.04	10.34	5.62	1.67	2.52	6.89	8.81

1884.

1	7.00	8.50	16.45	16.90	12.00	9.00	8.15	5.40	3.00	5.40	7.10	5.60
2	6.90	8.75	16.10	17.10	12.00	8.80	8.00	5.40	2.80	5.40	6.90	5.50
3	7.00	8.70	15.75	17.30	11.90	8.70	7.90	5.40	2.60	5.60	6.80	5.30
4	7.10	8.75	15.45	17.35	11.75	8.60	7.80	5.50	2.40	5.80	6.70	5.20
5	6.90	9.40	15.20	17.20	11.50	8.45	7.60	5.60	2.30	6.20	6.50	5.20
6	6.80	9.70	14.95	17.10	11.55	8.35	7.30	5.70	2.20	6.50	6.40	5.10
7	6.80	10.10	14.65	17.00	11.85	8.15	7.10	5.70	2.20	6.55	6.30	5.70
8	6.80	10.50	14.35	16.85	11.95	8.05	6.80	5.70	2.30	6.80	6.20	5.90
9	6.80	10.75	14.00	16.65	11.85	8.50	6.50	5.70	2.20	7.57	6.20	6.10
10	6.80	11.00	13.75	16.40	11.75	8.90	6.20	5.60	2.20	8.20	6.10	6.25
11	6.70	11.25	13.45	16.10	11.65	9.05	6.00	5.60	2.50	8.40	6.10	6.40
12	6.55	12.10	13.35	15.90	11.60	9.00	5.90	5.40	2.80	8.40	6.00	6.50
13	6.55	12.80	13.20	15.60	11.60	8.90	5.80	5.30	3.00	8.55	5.90	6.75
14	6.50	13.20	13.10	15.35	11.70	8.75	5.90	5.10	2.50	8.65	5.90	6.80
15	6.45	13.65	12.95	15.10	11.75	8.60	6.10	4.80	2.20	8.70	5.80	6.90
16	6.40	13.90	12.85	14.80	11.75	8.60	6.20	4.80	2.00	8.80	5.70	7.00
17	6.35	14.10	12.70	14.50	11.75	8.70	6.30	4.20	1.80	8.80	5.60	6.90
18	6.25	14.50	12.65	14.25	11.65	8.75	6.40	3.80	1.70	8.80	5.50	7.80
19	6.00	14.60	12.65	14.00	11.60	8.75	6.50	3.40	1.70	8.70	5.40	7.75
20	5.90	15.60	12.70	13.80	11.40	8.95	6.40	3.00	1.60	8.60	5.30	7.75
21	5.85	15.75	12.75	13.60	11.30	8.90	6.40	2.70	1.50	8.40	5.20	7.65
22	5.70	15.85	12.80	13.40	11.15	8.80	6.30	2.40	1.50	8.30	5.10	7.50
23	5.50	16.00	13.00	13.20	10.90	8.75	6.30	2.30	1.40	8.10	5.50	7.25
24	5.10	16.20	13.20	13.10	10.70	8.75	6.20	2.10	2.73	8.00	5.90	7.10
25	4.90	16.35	13.80	12.90	10.50	8.70	6.00	2.00	4.00	7.80	6.40	6.90
26	4.75	16.45	14.20	12.75	10.30	8.65	5.80	1.90	4.27	7.70	6.30	6.85
27	4.60	16.60	14.80	12.60	10.20	8.60	5.70	1.80	4.77	7.60	6.10	6.85
28	4.50	16.60	15.50	12.40	9.95	8.50	5.60	1.80	5.30	7.60	5.90	6.85
29	4.35	16.55	15.90	12.25	9.75	8.35	5.40	2.00	5.35	7.60	5.80	7.25
30	4.40	.....	16.40	12.10	9.45	8.30	5.30	2.30	5.40	7.40	5.60	8.25
31	6.70	.....	16.70	.....	9.20	.....	5.30	2.80	.....	7.20	.....	8.90
Mean	6.09	13.04	14.17	14.92	11.22	8.66	6.42	4.04	2.74	7.62	6.01	6.70

Gauge readings on the Illinois River at La Grange, Ill.—Continued.

[Readings are referred to low water of 1879.]

1885.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	9.00	14.20	9.45	13.90	16.00	8.50	7.45	4.10	4.95	5.35	7.80	9.20
2	9.00	14.00	9.50	13.80	15.90	8.35	7.50	4.60	4.95	5.40	8.00	9.10
3	9.20	13.90	10.00	13.70	15.70	8.10	7.50	4.70	4.95	5.40	8.20	9.05
4	9.40	13.80	10.90	13.65	15.50	8.05	7.45	4.90	4.95	5.30	8.35	8.90
5	9.80	13.75	11 50	13.60	15.20	8.05	7 30	4.95	4.90	5.20	8 40	8.70
6	11.60	13.70	12.00	13.55	14.80	8.25	7.00	5.00	4.70	5.10	8.60	8.50
7	12.20	13.60	12.30	13.55	14.75	8.20	6.70	5.20	4.50	5.05	9.00	8.25
8	14.10	13.50	12.60	13.50	14.70	8.15	6.40	5.35	4.75	5.00	9.10	8.00
9	15.10	13.40	12.90	13.40	14.50	8.10	5.90	5.30	4.75	5.05	9.00	7.75
10	15.60	13.25	14.00	13.40	14.00	8.05	5.50	5.25	4.70	5.10	8.90	7.35
11	16.05	13.15	14.00	13.40	13.90	8.00	5.20	5.20	4.60	5.15	8.90	6.90
12	16.30	13.00	14.35	13.40	13.60	7.90	5.00	5.15	4.50	5.20	9.00	6.80
13	16.30	12.70	14.70	13.50	13.40	7.90	5.00	5.10	5.15	5.25	9.15	7.30
14	16.25	12.40	15.00	13.80	13.10	8.10	5.10	5.00	6.05	5.30	9.35	7.60
15	16.00	12.20	15.20	13.90	12.90	8.30	5.25	4.90	5.85	5.30	9.50	7.85
16	15.80	12.00	15.40	13.95	12.60	8.30	5.40	4.75	5.60	5.30	9.70	8.05
17	15.60	11.70	15.45	13.90	12.40	8.15	5.30	4.60	5.50	5.30	9.85	8.10
18	15.70	11.50	15.45	13.85	12.10	8.00	5.25	4.40	5.40	5.30	10.00	8.10
19	15.70	11.20	15.50	13.85	11.90	7.80	5.20	4.70	5.40	5.35	10.10	8.10
20	15.70	11.00	15.50	13.85	11.50	7.65	5.15	5.10	5.45	5.35	10.15	8.10
21	15.60	10.70	15.40	13.85	11.25	7.10	5.10	5.15	5.45	5.55	10.20	8.10
22	15.50	10.50	15.30	14.10	10.90	8.10	5.00	4.50	5.45	5.70	10.25	8.00
23	15.40	10.25	15.20	14.40	10.60	8.75	5.00	4.05	5.45	5.80	10.25	8.00
24	15.25	10.00	15.10	15.10	10.30	8.30	5.05	3.70	5.40	5.85	10.15	8.10
25	15.10	9.80	15.00	15.40	10.10	8.00	5.10	3.75	5.35	6.30	10.10	8.15
26	14.90	9.60	14.90	15.60	9.80	7.70	5.10	3.90	5.35	6.60	10.00	8.15
27	14.80	9.45	14.70	15.80	9.50	7.50	4.95	4.10	5.35	6.75	9.10	8.20
28	14.70	9.40	14.60	16.00	9.20	7.50	4.75	4.50	5.30	7.00	9.75	8.25
29	14.60	.....	14.50	16.10	9.05	7.45	4.50	4.70	5.35	7.20	9.50	8.35
30	14.50	.....	14.35	16.10	8.90	7.45	4.30	4.85	5.35	7.40	9.30	8.50
31	14.40	.....	14.15	.....	8.70	.....	4.15	4.95	.....	7.60	.....	9.20
Mean	14.17	12.06	13.84	14.20	12.48	7.99	6.40	4.72	5.18	5.69	9.32	8.15

1886.

1	9.75	12.85	16.35	14.55	12.90	13 40	5.40	1.35	1.20	2.65	2.65	2.15
2	10.00	12.65	16.10	14.60	12.70	13.15	5.20	1.35	1.25	2.50	2.55	2.00
3	10.25	12.50	15.90	14.60	12.50	12.85	5.00	1.30	1.25	2.60	2.50	2.00
4	10.50	12.25	15.70	14.50	12.35	12.45	4.75	1.30	1.20	2.60	2.45	2.00
5	10.90	12.05	15.50	14.40	12.20	12.20	4.50	1.25	1.20	2 60	2.40	2.10
6	11.20	12.60	15.35	14.30	12.15	11.90	4.20	1.20	1.15	2.65	2.25	2.20
7	11.50	11.85	15.10	14.20	12.10	11.60	3.90	1.15	1.15	2.70	2.20	2.25
8	11.70	11.80	14.90	14.10	12.05	11.25	3.65	1.15	1.20	2.70	2.20	2.35
9	11.80	11.40	14.70	14.00	11.95	10.90	3.40	1.20	1.25	2.60	2.20	2.40
10	12.50	11.50	14.60	13.90	12.05	10.60	3.20	1.20	1.30	2.60	2.20	2.50
11	13.00	12.00	14.30	13.80	12.10	10.30	2.95	1.15	1.30	2.50	2.20	2.55
12	13.40	12.40	14.10	13.70	12.10	9.95	2.85	1.10	1.30	2.50	2.15	2.55
13	13.60	12.50	13.90	13.60	12.00	9.60	2.65	1.20	1.30	2.50	2.10	2.65
14	13.80	12.65	13.80	13.50	12.10	9.40	2.50	1.40	1.25	2.55	2.05	2.65
15	14.00	13.10	13.70	13.40	12.30	9.20	2.40	2.40	1.15	2.45	2.00	2.60
16	14.10	13.35	13.50	13.40	12.45	8.80	2.30	3.10	1.20	2.40	2.00	2.55
17	14.20	13.60	13.40	13.60	12.55	8.60	2.25	3.00	1.30	2.30	2.00	2.55
18	14.25	13.85	13.20	13.70	12.55	8.40	2.20	2.60	1.40	2.20	2.00	2.50
19	14.20	14.65	13.10	13.70	12.55	8.20	2.15	2.25	1.45	2.15	1.95	2.45
20	14.20	15.40	13.00	13.65	12.70	8.10	2.15	2.00	1.50	2.10	1.90	2.35
21	14.00	15.90	13.00	13.60	12.85	7.90	2.10	1.80	1.65	2.10	1.90	2.35
22	13.90	16.20	13.10	13.60	13.05	7.70	2.05	1.60	1.90	2.10	1.90	2.30
23	13.75	16.30	13.20	13.65	13.30	7.50	2.00	1.45	2.05	2.10	1.90	2.25
24	13.70	16.40	13.40	13.60	13.50	7.25	1.90	1.40	2.20	2.40	1.90	2.25
25	13.65	16.60	13.60	13.60	13.65	7.00	1.80	1.40	2.65	2.90	1.90	2.20
26	13.60	16.75	13.70	13.55	13.80	6.75	1.70	1.35	2.90	2.95	2.05	2.15
27	13.50	16.65	13.90	13.45	13.95	6.50	1.60	1.30	3.07	3.00	2.05	2.20
28	13.40	16.50	14.10	13.30	13 95	6.20	1.50	1.25	3.10	2.90	2.05	2.20
29	13.25	.....	14.30	13.15	13.95	5.90	1.45	1.25	2.80	2.80	2.05	2.20
30	13.10	.....	14.40	13.05	13.80	5.70	1.40	1.20	2.80	2.75	2.05	2.20
31	13.00	.....	14.50	.....	13.60	.....	1.40	1.20	.....	2.70	.....	2.20
Mean	12.83	13.77	14.24	13.79	12.77	9.31	2.79	1.54	1.68	2.53	2.12	2.32

Gauge readings on the the Illinois River at La Grange, Ill.—Continued.

[Readings are referred to low water of 1879.]

1887.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	2.20	8.25	16.65	10.25	5.30	2.00	1.00	0.20	0.18	0.70	0.95	1.00
2	2.20	8.45	16.45	10.08	5.35	1.82	0.90	0.20	0.15	0.65	0.90	0.95
3	2.15	8.40	16.25	9.90	5.00	1.80	0.80	0.15	0.15	0.60	0.95	1.00
4	2.15	8.45	16.05	9.55	4.80	1.80	0.90	0.10	0.20	0.58	0.95	1.35
5	2.15	8.35	15.85	9.35	4.70	1.80	1.00	0.10	0.20	0.58	0.95	1.80
6	2.15	8.35	15.55	9.20	4.60	1.80	1.10	0.05	0.25	0.68	0.90	2.00
7	2.15	8.35	15.35	8.90	4.60	1.80	1.10	0.05	0.20	0.70	0.85	2.05
8	2.20	8.58	15.15	8.75	4.55	1.90	1.10	0.05	0.15	0.70	0.80	2.05
9	2.25	8.69	15.00	8.55	4.40	2.07	1.10	0.05	0.15	0.72	0.80	2.10
10	2.25	9.28	14.80	8.35	4.40	2.20	1.05	0.25	0.15	0.72	0.82	2.10
11	2.25	10.35	14.55	8.20	4.35	2.20	1.00	0.00	0.17	0.80	0.88	2.15
12	2.30	10.77	14.35	7.85	4.30	2.10	0.95	—0.08	0.20	0.90	0.85	2.20
13	2.30	11.52	14.10	7.65	4.30	2.10	0.85	—0.03	0.22	0.90	0.80	2.20
14	2.35	12.30	14.00	7.45	4.25	2.00	0.85	0.08	0.20	0.85	0.80	2.20
15	2.40	13.37	13.85	7.10	4.20	2.10	0.85	0.20	0.15	0.85	0.82	2.25
16	2.45	14.22	13.70	6.85	4.05	2.10	0.80	0.27	0.15	0.85	0.85	2.25
17	2.45	14.77	13.50	6.75	3.95	2.00	0.70	0.35	0.20	0.85	0.80	2.30
18	2.50	15.50	13.35	6.60	3.75	1.90	0.60	0.40	0.20	0.85	0.72	2.35
19	2.50	15.90	13.20	6.40	3.55	1.80	0.50	0.40	0.20	0.85	0.70	2.40
20	2.50	16.42	13.00	6.20	3.35	1.70	0.60	0.45	0.20	0.85	0.58	2.48
21	2.50	16.60	12.80	6.00	3.15	1.60	0.65	0.47	0.20	0.80	0.50	2.50
22	2.50	16.85	12.58	5.90	3.00	1.50	0.60	0.45	0.20	0.80	0.55	2.52
23	4.30	17.05	12.38	5.80	2.90	1.40	0.50	0.37	0.20	0.80	0.60	2.55
24	5.70	17.10	12.10	5.80	2.80	1.30	0.50	0.35	0.20	0.80	0.65	2.60
25	6.90	17.15	11.85	5.70	2.70	1.20	0.45	0.40	0.25	0.80	0.82	2.65
26	7.60	17.15	11.68	5.75	2.55	1.10	0.45	0.35	0.27	0.80	0.92	2.70
27	7.90	16.92	11.45	5.80	2.45	1.00	0.40	0.35	0.30	0.90	1.00	2.72
28	7.80	16.78	11.20	5.60	2.35	1.00	0.35	0.30	0.40	0.90	1.05	2.75
29	7.80	.....	10.95	5.40	2.28	1.00	0.25	0.30	0.63	0.90	1.02	2.70
30	7.90	.....	10.75	5.25	2.17	1.00	0.25	0.25	0.72	0.90	1.00	2.75
31	8.10	.....	10.50	.....	2.07	.....	0.25	0.20	.....	0.90	.....	2.80
Mean	3.70	12.71	13.64	7.36	3.75	1.70	0.72	0.23	0.24	0.79	0.83	2.21

1888.

1	2.80	6.58	9.70	13.52	8.78	11.40	7.92	7.48	1.95	0.70	1.22	2.00
2	2.80	6.40	10.42	13.72	8.58	11.58	7.55	7.10	1.85	0.62	1.20	2.00
3	2.85	6.32	11.10	13.80	8.45	11.85	7.48	6.58	1.80	0.58	1.20	1.95
4	2.90	6.28	11.70	13.85	8.38	12.10	7.32	6.12	1.72	0.68	1.18	1.95
5	2.90	6.42	11.98	13.85	8.32	12.30	7.30	5.65	1.62	0.68	1.35	1.82
6	3.60	6.50	12.32	13.80	8.18	12.38	7.25	5.28	1.52	0.65	1.48	1.85
7	7.05	6.45	12.68	13.72	8.18	12.42	7.35	4.85	1.45	0.70	1.55	1.92
8	7.50	6.45	12.95	13.62	8.55	12.45	7.50	4.42	1.40	0.75	1.68	2.00
9	7.22	6.45	13.20	13.50	8.42	12.42	8.35	4.05	1.32	0.75	1.95	2.00
10	7.00	6.40	13.42	13.38	8.25	12.35	9.25	3.85	1.22	0.78	2.68	1.95
11	6.95	6.42	13.48	13.22	8.08	12.20	9.48	3.68	1.18	0.78	3.14	1.92
12	6.88	6.48	13.48	13.05	7.95	12.05	9.20	3.60	1.10	0.75	3.32	1.82
13	6.78	6.55	13.45	12.85	7.88	11.82	8.92	3.62	1.05	0.70	3.15	1.80
14	6.72	7.10	13.40	12.65	7.98	11.52	8.88	3.45	1.00	0.70	2.90	1.80
15	6.80	7.62	13.25	12.42	8.12	11.30	9.05	3.30	0.95	0.70	2.85	1.75
16	7.05	7.95	13.15	12.25	8.25	11.00	9.18	3.25	0.95	0.68	2.90	1.78
17	7.20	8.00	13.05	12.02	8.38	10.70	9.25	3.55	0.92	0.70	2.88	1.75
18	7.30	8.02	12.98	11.82	8.48	10.42	9.35	3.98	0.90	0.70	2.85	1.82
19	7.40	8.22	12.95	11.55	8.68	10.40	9.45	3.95	0.90	0.78	2.85	1.92
20	7.42	8.90	13.08	11.32	8.80	10.22	9.45	3.75	0.90	0.98	2.85	2.00
21	7.50	9.32	13.15	11.10	8.98	9.85	9.45	3.52	0.90	1.20	2.72	1.98
22	7.50	9.60	13.02	10.85	9.25	9.88	9.38	3.30	1.38	1.48	2.58	1.95
23	7.45	8.65	12.92	10.65	9.55	9.65	9.25	3.15	1.32	1.50	2.58	1.95
24	7.38	8.50	12.82	10.38	9.75	9.25	9.08	3.00	1.25	1.50	2.48	1.88
25	7.28	8.80	12.92	10.15	9.95	8.95	8.90	2.88	1.25	1.50	2.40	1.92
26	7.05	8.92	13.12	9.90	10.05	8.72	8.65	2.72	1.18	1.42	2.28	2.08
27	6.85	9.28	13.20	9.65	10.52	8.78	8.65	2.62	1.05	1.28	2.20	2.40
28	6.60	9.18	13.22	9.45	11.15	8.78	8.90	2.52	0.85	1.30	2.12	2.72
29	6.35	9.35	13.30	9.15	11.25	8.52	8.85	2.35	0.80	1.30	2.02	2.92
30	6.12	.....	13.30	8.98	11.30	8.22	8.40	2.22	0.72	1.25	2.00	2.95
31	6.42	.....	13.38	.....	11.30	.....	7.85	2.12	.....	1.28	.....	2.95
Mean	6.25	7.62	9.87	12.01	9.02	10.78	8.61	3.93	1.21	0.95	1.79	2.05

Gauge readings on the Illinois River at La Grange, Ill.—Continued.

[Readings are referred to low water of 1879.]

1889.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	3.00	4.85	5.30	5.56	5.29	6.09	11.80	6.75	1.72	1.86	2.10	3.50
2	3.02	4.68	6.80	5.43	5.05	5.60	11.74	6.60	1.65	1.83	2.90	3.45
3	3.10	4.55	7.40	5.55	4.75	5.25	12.03	6.38	1.64	1.74	2.92	3.40
4	3.15	4.35	7.35	5.23	4.55	5.28	12.01	6.18	1.54	1.62	2.90	3.39
5	3.15	4.15	7.12	5.22	4.35	5.43	11.79	6.04	1.58	1.55	2.90	3.55
6	3.15	3.95	7.05	5.18	4.08	5.64	11.52	5.85	1.64	1.38	2.90	3.68
7	3.20	3.85	7.25	5.11	3.82	5.90	11.10	5.58	1.72	1.25	2.98	3.65
8	3.22	3.75	7.65	5.03	3.55	8.40	10.72	5.36	1.84	0.85	3.35	3.85
9	3.32	3.50	8.05	5.04	3.22	9.94	10.37	5.23	2.10	0.20	3.88	4.02
10	3.20	3.28	8.26	4.98	3.08	10.22	10.04	5.10	2.50	—1.10*	4.00	4.35
11	3.15	3.18	8.36	4.91	3.00	10.36	9.65	4.82	2.93	—0.75*	4.10	4.75
12	3.18	3.08	8.35	4.84	3.05	10.40	9.48	4.55	3.30	—1.00*	4.18	5.25
13	3.18	3.02	8.44	4.80	3.00	10.06	9.15	4.38	3.54	0.00	4.18	5.40
14	3.38	3.00	8.42	5.08	2.75	9.78	8.75	4.17	3.58	0.40	4.20	5.48
15	3.70	2.92	8.38	5.08	2.85	9.76	8.40	3.96	3.56	0.50	4.32	5.65
16	4.20	2.95	8.18	4.97	2.82	9.80	8.04	3.75	3.48	0.60	4.40	5.82
17	4.82	2.98	7.95	4.89	2.72	9.88	7.85	3.72	3.36	1.00	4.40	6.10
18	5.52	2.98	7.88	4.85	3.00	10.08	7.70	3.56	3.22	1.15	4.45	6.28
19	5.52	2.88	7.75	7.10	4.25	10.42	7.64	3.37	3.06	1.30	4.45	6.45
20	5.50	2.95	7.62	8.15	4.40	10.60	7.75	3.16	2.92	0.90	4.40	6.62
21	5.58	3.08	7.45	8.24	3.70	11.12	7.78	3.00	2.76	1.15	4.40	6.75
22	5.62	3.20	7.18	7.82	3.25	11.28	7.80	2.90	2.60	1.30	4.15	6.82
23	5.60	3.42	6.95	7.28	3.00	11.32	7.80	2.75	2.47	1.30	4.00	6.80
24	5.62	3.80	6.84	6.82	2.89	11.39	7.86	2.58	2.32	1.18	3.98	6.88
25	5.68	3.88	6.73	6.58	2.82	11.54	7.83	2.40	2.26	1.15	3.88	6.95
26	5.75	3.98	6.56	6.35	2.71	11.66	7.72	2.26	2.18	1.14	3.80	6.80
27	5.62	4.08	6.37	6.08	2.64	11.77	7.60	2.12	2.11	1.13	3.75	6.78
28	5.48	4.08	6.18	5.92	2.74	11.80	7.44	2.02	2.02	1.13	3.65	6.70
29	5.30	.....	6.00	5.74	4.30	11.81	7.28	1.88	1.98	1.12	3.55	6.48
30	5.22	.....	5.86	5.54	6.95	11.80	7.07	1.81	1.94	1.39	3.52	6.40
31	5.05	.....	5.72	.....	6.65	.....	6.92	1.78	.....	1.42	.....	6.40
Mean	4.33	3.59	7.27	5.78	3.72	9.48	9.05	4.00	2.45	0.92	3.75	5.43

* These low readings caused by closing of dam in process of construction.

MONTHLY MEANS.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly mean.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1883	7.41	11.36	16.71	12.77	12.18	13.04	10.34	5.62	1.67	2.52	6.89	8.81	9.11
1884	6.09	13.04	14.17	14.92	11.22	8.66	6.42	4.04	2.74	7.62	6.01	6.70	8.47
1885	14.17	12.06	13.84	14.20	12.48	7.99	6.40	4.72	5.18	5.69	9.32	8.15	9.52
1886	12.83	13.77	14.24	13.79	12.77	9.31	2.79	1.54	1.68	2.53	2.12	2.32	7.47
1887	3.70	12.71	13.64	7.36	3.75	1.70	0.72	0.23	0.24	0.79	0.83	2.21	3.99
1888	6.25	7.62	9.87	12.01	9.02	10.78	8.61	3.93	1.21	0.95	1.79	2.05	6.17
1889	4.33	3.59	7.27	5.78	3.72	9.48	9.05	4.00	2.45	0.92	3.75	5.43	4 98
Mean for 7 years.	7.82	10.59	12.82	11.55	9.31	8.71	6.33	3.44	2.17	3.00	4.39	5.10	7.10

Discharge observations on Illinois River at Ottawa, Ill.

[Zero of gauge at assumed low water. Price current meter.]

Date.	Gauge.	Mean velocity per second.	Area.	Discharge per second.	Date.	Gauge.	Mean velocity per second.	Area.	Discharge per second.
1889.	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	1889.	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*
Oct. 24	0.55	0.766	1,524.1	1,168.4	Nov. 25	1.32	1.303	2,088.8	2,722.7
Oct. 28	0.62	0.887	1,548.7	1,374.2	Nov. 12	1.34	1.286	2,100.2	*2,702.3
Oct. 9	0.63	0.779	1,539.5	*1,200.6	Nov. 21				
Oct. 17					Sept. 13	1.39	1.268	2,151.4	2,727.8
Oct. 3	0.66	0.921	1,468.0	1,352.5	Aug. 14	1.40	1.361	2,111.3	2,873.2
May 27	0.67	0.887	1,643.5	*1,462.1	Apr. 26	1.45	1.459	2,147.4	3,133.6
Oct. 21					July 11	1.47	1.470	2,121.3	3,119.3
Oct. 1	0.71	0.847	1,464.6	1,252.1	Aug. 9	1.51	1.479	2,172.9	3,214.4
Oct. 7	0.72	0.824	1,554.3	1,300.3	July 9	1.55	1.566	2,183.9	3,417.4
Oct. 14	0.75	0.879	1,612.3	1,417.3	Aug. 7	1.59	1.545	2,210.5	3,414.2
May 22	0.76	0.909	1,819.0	1,654.7	July 13	1.62	1.627	2,207.5	3,590.7
Sept. 27	0.80	0.859	1,631.0	1,402.4	Nov. 5	1.67	1.497	2,259.3	3,382.2
Sept. 3	0.81	0.787	1,761.9	1,385.0	July 8	1.68	1.654	2,240.8	*3,657.7
Sept. 25	0.84	0.855	1,813.1	1,552.3	Aug. 3				
May 30	0.85	0.936	1,786.4	*1,672.2	Sept. 3	1.87	1.596	2,359.1	3,763.2
Aug. 30					Apr. 23	1.88	1.934	2,346.8	4,538.5
May 11	0.87	1.016	1,870.0	1,900.0	July 6	1.94	1.874	2,364.7	4,431.3
May 20	0.88	1.010	1,877.0	1,894.4	July 27	2.01	1.890	2,365.6	4,469.9
Sept. 23	0.89	0.844	1,876.9	1,583.8	July 1	2.06	2.005	2,468.4	4,825.5
Sept. 21	0.90	0.880	1,817.4	1,600.6	Aug. 1	2.07	2.013	2,414.3	4,859.9
Nov. 2	0.92	0.997	1,914.7	1,912.9	July 3	2.16	2.074	2,475.3	*5,231.3
Aug. 27	0.95	0.930	1,861.5	1,730.6	July 25				
May 14	0.98	1.035	1,938.6	2,000.5	June 27	2.48	2.310	2,555.8	5,904.7
May 7	1.00	1.032	1,926.0	*1,986.8	July 30	2.55	2.346	2,597.3	6,095.3
Aug. 24					July 23	2.62	2.394	2,633.6	6,307.1
May 16	1.01	1.094	1,906.6	2,086.9	June 26	2.90	2.609	2,765.2	7,214.6
Sept. 17	1.03	1.148	1,998.7	2,294.0	June 5	3.14	2.668	2,945.1	7,853.0
Nov. 18	1.04	1.065	1,907.3	2,031.2	June 14	3.17	2.743	2,896.7	7,944.5
Aug. 21	1.05	1.036	1,966.4	2,038.6	July 20	3.20	2.740	2,878.3	7,883.9
May 3	1.10	1.188	1,936.5	2,298.3	June 13	3.65	3.133	3,097.8	9,705.2
Sept. 5	1.13	1.021	2,015.9	2,043.1	July 18	3.75	3.290	3,129.3	10,294.1
Apr. 30	1.16	1.263	1,971.9	2,490.8	June 24	3.80	3.289	3,202.7	10,532.5
Aug. 19	1.17	1.098	2,032.2	2,232.9	June 3	3.85	3.263	3,292.9	10,746.1
Nov. 9	1.23	1.183	2,052.6	†2,429.4	June 10	3.94	3.349	3,271.0	10,953.2
Nov. 15					June 21	5.00	4.232	3,707.7	15,690.9
Aug. 12	1.28	1.255	2,049.1	2,571.8	June 17	5.07	4.192	3,795.4	15,911.4
Aug. 16	1.31	1.244	2,066.4	2,569.2	July 16	5.22	4.508	3,826.0	17,249.8

* Mean discharge for two days.

Discharge observations on Illinois River at Peru, Ill., 1889.

[Gauge readings referred to gauge whose zero was 0.20 feet below low water of 1888. Price current meter.]

Date.	Gauge.	Mean velocity per second.	Area.	Discharge per second.	Date.	Gauge.	Mean velocity per second.	Area.	Discharge per second.
1889.	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*	1889.	*Feet.*	*Feet.*	*Sq. feet.*	*Cubic feet.*
Oct. 22	0.62	0.410	3,793.6	1,504.2	Nov. 23	2.00	0.780	4,406.1	3,433.3
Oct. 10	0.66	0.374	3,694.8	1,381.9	Sept. 12	2.04	0.739	4,633.0	3,423.4
Oct. 15	0.75	0.369	3,978.8	1,471.5	Apr. 9	2.11	0.857	4,669.4	4,008.3
May 28	0.78	0.455	4,026.4	1,834.2	Apr. 27	2.17	0.928	4,794.0	4,446.0
Oct. 29	0.80	0.337	3,909.1	1,316.3	Nov. 4	2.18	1.053	4,544.5	4,788.7
Oct. 4	0.81	0.327	3,993.3	1,302.8	Nov. 7	2.20	0.905	4,523.6	4,080.0
Oct. 18	0.83	0.387	3,977.2	1,540.0	July 10	2.21	0.840	4,507.1	3,788.8
Oct. 26	0.84	0.356	3,954.2	1,407.5	Aug. 2	2.45	1.122	4,754.6	5,337.9
Oct. 2	0.88	0.347	4,047.7	1,404.3	Apr. 25	2.54	1.070	4,991.6	5,338.0
May 10 / May 21	0.90	0.564	4,097.0	*2,313.0	July 8 / July 29	2.72	1.069	4,774.0	*5,111.5
May 18	1.02	0.559	4,182.9	2,338.9	Apr. 16	2.73	1.180	4,999.4	5,901.6
Aug. 20	1.04	0.736	3,979.0	2,930.1	Apr. 5	2.77	1.266	5,009.6	6,339.8
Sept. 28	1.07	0.368	4,107.6	1,510.5	Sept. 9	2.83	1.024	5,013.7	5,132.2
May 15 / Sept. 24	1.13	0.555	4,121.5	*2,243.3	Apr. 19	2.86	1.308	5,116.5	6,693.3
					July 30	2.89	1.285	4,904.7	6,301.8
Aug. 17 / Sept. 2	1.14	0.597	4,035.2	*2,406.9	July 26	2.95	1.090	4,917.6	5,357.9
					July 31	2.98	1.293	4,981.2	6,440.9
May 6 / Sept. 4	1.19	0.578	4,181.0	*2,440.5	Apr. 2	2.99	1.353	5,111.5	6,916.9
					July 24	3.41	1.213	5,148.9	6,248.1
Aug. 29	1.22	0.375	4,111.2	1,542.7	June 6	3.57	1.427	5,326.5	7,601.5
Aug. 15	1.26	0.738	4,113.8	3,271.0	July 5	3.61	1.137	5,192.1	5,901.4
Sept. 20	1.28	0.550	4,275.8	2,347.9	Apr. 20	3.82	1.813	5,498.4	9,965.4
					Apr. 21	3.84	1.726	5,544.5	9,570.8
May 31 / Aug. 26	1.30	0.546	4,190.6	*2,297.5	July 2	3.95	1.093	5,368.7	5,864.3
Aug. 23	1.35	0.478	4,126.0	1,972.1	July 22	4.04	1.412	5,417.7	7,650.0
Aug. 13	1.36	0.854	4,133.3	3,530.0	June 4 / July 15	4.38	2.136	5,657.3	*12,066.2
May 2 / Sept. 18	1.39	0.649	4,323.7	*2,808.2					
					June 29	4.65	0.998	5,685.9	5,670.1
Aug. 10	1.49	0.820	4,221.6	3,460.4	June 15	4.68	1.664	5,831.0	9,704.0
Sept. 16	1.54	0.542	4,368.9	2,372.1	June 14	4.75	1.671	5,868.0	9,804.8
Nov. 19	1.60	0.520	4,104.4	2,134.8	July 19	4.76	1.712	5,688.4	9,739.8
Aug. 8	1.70	0.871	4,363.1	3,799.2	June 27	5.53	1.200	6,200.8	7,438.9
Nov. 26	1.74	0.568	4,301.0	2,443.0	June 12	5.60	2.285	6,267.0	14,322.5
Nov. 16	1.80	0.620	4,314.7	2,673.1	July 16	5.88	2.877	6,255.4	17,997.2
Apr. 29	1.82	0.824	4,532.0	3,735.4	June 26	5.90	1.340	6,359.8	8,518.6
Sept. 6	1.88	0.753	4,357.4	3,283.3	July 17	6.09	2.441	6,322.7	15,437.3
Nov. 11	1.90	0.690	4,367.6	3,009.1	June 25	6.50	1.598	6,721.4	10,756.1
Aug. 6	1.94	0.964	4,490.8	4,321.8	June 18	7.40	2.773	7,026.3	19,480.5
Apr. 12	1.95	0.938	4,577.6	4,295.1	June 22	7.94	2.502	7,236.5	18,107.8

*Mean discharge for two days.

I.—*List of merchant steam-boats navigating the Mississippi River and its tributaries with a depth greater than 9 feet.*

[Data obtained from the twentieth annual official list, published 1889.]

List No.	Official No.	Name.	Tonnage.		Length.	Breadth.	Depth.	Where built.	Home port.
			Gross.	Net.					
			Tons.	*Tons.*	*Feet.*	*Feet.*	*Ft.*		
1	80949	City of Delta	1,671.07	1,436.17	301.5	77.6	9.8	Pittsburgh, Pa	St. Louis, Mo.
2	135377	Ed. Richardson	2,048.34	2,048.34	303.0	48.6	9.9	Louisville, Ky	Louisville, Ky.
3	130160	Natchez	1,477.27	1,477.27	302.2	46.8	9.6	Cincinnati, Ohio	Cincinnati, Ohio.

Three boats, 4,961.78 total tonnage; 4 per cent. of all boats, and 2.7 per cent. of tonnage navigating Mississippi River.

II.—*List of merchant steam-boats navigating the Mississippi River and its tributaries with a depth including and between 8 and 9 feet.*

[Data obtained from the twentieth annual official list, published 1889.]

List No.	Official No.	Name.	Tonnage.		Length.	Breadth.	Depth.	Where built.	Home port.
			Gross.	Net.					
			Tons.	*Tons.*	*Feet.*	*Feet.*	*Ft.*		
1	105818	Annie P. Silver	1,199.52	1,199.52	298.6	40.7	8.8	Cincinnati, Ohio	St. Louis, Mo.
2	125957	City of Baton Rouge	1,603.96	1,603.96	290.0	48.0	8.7	Jeffersonville, Ind.	Do.
3	126458	City of Monroe	1,038.25	1,038.25	275.0	45.0	8.0	do	Do.
4	125959	City of New Orleans	1,586.28	1,586.28	290.0	48.0	8.5	do	Do.
5	126101	City of St Louis	1,614.02	1,565.77	300.0	49.0	8.8	do	Do.
6	125932	City of Vicksburg	1,356.52	1,356.52	273.7	44.5	8.2	do	Do.
7	135445	Enterprise	1,041.20	1,041.20	270.1	40.7	9.0	Algiers, La	New Orleans, La.
8	75983	Grand Republic	1,985.92	1,959.39	260.0	50.0	8.5	Pittsburgh, Pa	St. Louis, Mo.
9	76108	James Lee	747.94	747.94	237.0	35.0	8.0	do	Memphis, Tenn.
10	14412	Kate Adams	1,033.61	913.42	247.0	72.4	9.0	do	Do.
11	150339	Pargoud	711.94	711.94	242.0	43.0	8.0	Jeffersonville, Ind.	Louisville, Ky.
12	110760	Rosa Lee	1,059.71	818.74	220.0	36.0	8.0	Paducah, Ky	Memphis, Tenn.
13	24931	Thos. Sherlock	1,353.02	1,353.02	290.0	46.0	8.2	Cincinnati, Ohio	Cincinnati, Ohio.
14	80864	W. W. O'Neil	778.96	778.96	201.0	46.2	8.0	Pittsburgh, Pa	Pittsburgh, Pa.

Fourteen boats, 16,674.91 total tonnage; 1.9 per cent. of all boats, and 9.2 per cent. of tonnage navigating Mississippi River.

III.—*List of merchant steam-boats navigating the Mississippt River and its tributaries with a depth between 7 and 8 feet, including 7 feet.*

[Data obtained from the twentieth annual official list, published 1889.]

List No.	Official No.	Name.	Tonnage.		Length	Breadth.	Depth.	Where built.	Home port.
			Gross.	Net.					
			Tons.	*Tons.*	*Feet.*	*Feet.*	*Ft.*		
1	106105	Arkansas City...	1,236.99	1,236 99	273.7	44.7	7.8	Jeffersonville, Ind.	St. Louis, Mo.
2	3138	Belle Memphis...	1,222.89	1,222.89	267.0	42.7	7.6	....do	do
3	3307	Big Sandy.....	770.17	770.17	292.0	47.0	7.0	Cincinnati, Ohio..	Cincinnati, Ohio.
4	125569	Centennial.....	1,112.26	1,112.26	295.1	41.6	7.5	Madison, Ind.....	St. Louis, Mo.
5	125349	Chas. Morgan...	1,224.26	1,224.26	302.2	43.4	7.6	Cincinnati, Ohio ..	Cincinnati, Ohio.
6	125999	City of Cairo.....	1,266.12	1,266.12	271.2	44.0	7.8	Jeffersonville, Ind.	St. Louis, Mo.
7	125830	City of Providence	1,303.81	1,303.81	273.1	44.5	7.8	....do	do
8	125553	Coahoma	449.51	449.51	205.2	32.5	7.0	Metropolis, Ill	Memphis, Tenn.
9	126438	Crystal City.....	828.28	787.43	234.0	42.2	7.0	Jeffersonville, Ind.	St. Louis, Mo.
10	135364	Edward J. Gay ..	936.26	936.26	251.3	41.0	7.6	Cincinnati, Ohio ..	New Orleans, La.
11	8808	Emma C. Elliott.	660.16	660.16	214.0	36.2	7.0	Jeffersonville, Ind.	Paducah, Ky.
12	75273	Endeavor	633.91	484.09	234.8	41.8	7.1	Cincinnati, Ohio...	New Orleans, La.
13	85519	General Pierson.	485.42	485.42	202.0	42.0	7.2	Metropolis, Ill	Memphis, Tenn.
14	85565	Guiding Star.....	1,121.97	1,121.97	304.0	41.6	7.1	Cincinnati, Ohio...	Cincinnati, Ohio.
15	75461	John A. Wood...	687.52	687.52	198.0	40.0	7.0	Pittsburgh, Pa....	Pittsburgh, Pa.
16	130375	New South.....	932.95	846.55	257.0	42.6	7.0	Jeffersonville, Ind.	Evansville, Ind.
17	130108	New Mary Houston	1,163.93	1,163.93	287.0	41.0	7.4	....do	Cincinnati, Ohio.
18	155130	Oliver Bierne....	1,017.78	1,017.78	265.0	43.6	7.0	....do	New Orleans, La.
19	150141	Paris C. Brown..	903.87	903.87	261.0	39.8	7.3	Cincinnati, Ohio ..	Cincinnati, Ohio.
20	116188	S. E. Barlow.....	753.92	753.92	249.0	48.6	7.2	Madison, Ind	St. Louis, Mo.
21	115810	Sam Brown.....	474.10	474.10	177.0	39.0	7.2	Pittsburgh, Pa...	Pittsburgh, Pa.
22	80827	W. B. Duncan...	575.39	575.39	201.0	45.0	7.4	Jeffersonville, Ind.	Paducah, Ky.
23	81019	W. H. Osborn....	819.68	819.68	285.0	45.0	7.6	....do	do
24	80937	Warren.....	528.08	316.50	184.0	37.6	7.0	Cincinnati, Ohio...	New Orleans, La.
25	75273	Endeavor (iron)..	633.91	484.09	234.8	41.8	7.1	....do	do

Twenty-five boats, 21104.67 total tonnage; 3.4 per cent. of all boats, and 11.6 per cent. of tonnage navigating Mississippi River.

IV.—*List of merc ant steam-boats navigating the Mississippi River and its tributaries with a depth less than 7 feet.*

[Data obtained from the twentieth annual official list, published 1889.]

List No.	Official No.	Name.	Tonnage.		Length.	Breadth.	Depth.	Where built.	Home port.
			Gross.	Net.					
			Tons.	*Tons.*	*Ft.*	*Ft.*	*Ft.*		
1	106020	A. Durio	67.44	67.44	66.8	18.4	3.9	New Iberia, La	Brashear, La
2	105677	A. Reiling	76.06	76.06	100.0	21.0	4.4	Bellevue, Iowa	La Crosse, Wis.
3	76286	A. G. Henry	249.45	166.30	145.0	30.0	5.2	Evansville, Ind	Chattanooga, Tenn.
4	1343	A. J. Baker	268.94	268.94	142.0	24.6	5.0	Pittsburgh, Pa	St. Louis, Mo.
5	105895	A. J. Whitney	72.62	72.62	89.8	18.0	3.2	Rock Island, Ill	Burlington, Iowa.
6	105196	Abe McDonald	162.14	162.14	136.0	24.0	4.4	Pittsburgh, Pa	Cincinnati, Ohio.
7	105124	Abner Gile	124.18	124.18	110.0	21.0	3.0	Le Claire, Iowa	Galena, Ill.
8	106316	Abner O'Neil	197.74	197.74	150.0	28.4	3.8	Freedom, Pa	Wheeling, W. Va.
9	105456	Acorn	141.28	141.28	122.0	22.0	4.0	Pittsburgh, Pa	Pittsburgh, Pa.
10	106376	Adam Jacobs	268.33	217.82	162.2	28.0	4.6	do	Do.
11	106505	Addie E. Faison	241.50	241.50	135.0	30.6	4.9	Harmar, Ohio	Vicksburgh, Miss.
12	100160	Advance	120.72	120.72	124.0	22.6	4.0	Pittsburgh, Pa	Pittsburgh, Pa.
13	105956	do	82.83	59.79	70.0	18.0	2.0	Madison, Ark	Memphis, Tenn.
14	105539	Aggie	88.57	88.57	92.4	20.4	3.0	Manchester, Ohio	Kansas City, Mo.
15	105819	Agiia	114.94	114.94	109.0	37.6	6.0	Cincinnati, Ohio	New Orleans, La.
16	105947	Alarm	189.09	189.09	142.0	26.0	4.3	Pittsburgh, Pa	Pittsburgh, Pa.
17	3173	Albert S. Willis	132.99	132.99	153.1	26.5	3.6	Harmar, Ohio	St. Louis, Mo.
18	106398	Alert	158.98	158.98	130.0	24.1	2.2	Jeffersonville, Ind	Louisville, Ky.
19	105,228	Alex. Swift	329.73	329.73	151.3	28.2	5.7	Cincinnati, Ohio	Pittsburgh, Pa.
20	106,041	Alexis Dumestre	149.91	149.91	120.0	35.0	5.0	New Orleans, La	New Orleans, La.
21	105,889	Alfred Toll	97.44	97.44	126.2	24.0	3.5	La Crosse, Wis	La Crosse, Wis.
22	90,956	Alice	80.45	80.45	111.0	20.4	4.0	Covington, Ky	Memphis, Tenn.
23	105,195	Alice Brown	551.36	551.36	193.0	34.0	4.0	Pittsburgh, Pa	Pittsburgh, Pa.
24	106,329	Alice Le Blanc	81.97	81.97	111.7	24.0	4.4	Donaldsonville, La	New Orlerns, La.
25	106,428	Al. Martin	96.68	96.68	112.0	23.6	4.0	Covington, Ky	Cincinnati, Ohio.
26	106,149	Alpha	56.00	56.00	121.3	21.0	2.7	Jefferson, Tex	New Orleans, La.
27	80,730	Alto	363.16	363.16	166.0	34.6	4.9	Jeffersonville, Ind	Do.
28	105,975	Altonian	92.95	92.95	102.0	28.0	4.0	Cincinnati, Ohio	St. Louis, Mo.
29	105,712	Alvin	201.55	201.55	143.0	29.1	7.1	Jeffersonville, Ind	New Orleans, La.
30	105,690	Andes	622.18	622.18	220.0	39.8	5.7	Cincinnati, Ohio	Cincinnati, Ohio.
31	105,959	Andrew Christy	424.60	424.60	174.6	48.9	6.0	Louisville, Ky	St. Louis, Mo.
32	105,917	Andrew S. Bennett.	78.08	78.08	115.0	30.0	3.5	Sioux City, Iowa	Omaha, Nebr.
33	106,043	Annie L	114.69	114.69	115.8	20.3	3.1	Murraysville, W. Va.	Wheeling, W. Va.
34	105,867	Annie Cade	178.32	178.32	127.5	32.0	4.5	Leavenworth, Kans.	Kansas City, Mo.
35	105,863	Annie Lewis	81.14	81.14	93.4	27.0	4.2	Glasgow, Mo	Do.
36	80,657	Annie Roberts	342.86	342.86	168.0	30.0	5.2	Pittsburgh, Pa	Pittsburgh, Pa.
37	105,065	Ark	295.37	295.37	155.0	30.0	5.0	do	Cincinnati, Ohio.
38	105,366	Artemus Lamb	176.73	176.73	140.0	30.6	4.0	Clinton, Iowa	Galena, Ill.
39	106,325	Arthur Lambert	124.58	124.58	124.3	23.3	4.0	Covington, Ky	New Orleans, La.
40	105,574	Assumption	238.41	238.41	151.0	35.8	6.5	Jeffersonville, Ind	Do.
41	105,197	Athletic	81.76	81.76	103.0	19.0	3.9	Pittsburgh, Pa	Pittsburgh, Pa.
42	105,552	Augusta	155.97	155.97	100.0	29.0	5.0	Clinton, Iowa	Galena, Ill.
43	3,050	B. Hershey	170.00	170.00	125.3	27.5	3.9	Rock Island, Ill	Burlington, Iowa.
44	2,927	B. D. Wood	171.04	171.04	136.0	25.0	4.5	Pittsburgh, Pa	Pittsburgh, Pa.
45	2,940	B. F. Weaver	75.30	75.30	89.0	21.8	4.0	Galena, Ill	Paducah, Ky.
46	3,361	B. S. Rhea	203.77	203.77	165.0	27.1	4.6	Jeffersonville, Ind	Do.
47	3,160	B. T. Enos	147.68	147.68	152.5	24.0	4.1	Ironton, Ohio	Cincinnati, Ohio.
48	3,090	Bald Eagle	454.71	454.71	202.3	30.0	5.4	Madison, Ind	St. Louis, Mo.
49	2,810	Barnard	168.15	168.15	127.0	25.0	4.1	Parkersburgh, West Va.	Wheeling, W. Va.
50	3,132	Bart. E. Linehan	178.82	178.82	127.0	23.5	3.9	Burlington, Iowa	St. Louis, Mo.
51	3,340	Beaver	314.14	314.14	169.5	30.6	5.1	Cincinnati, Ohio	Pittsburgh, Pa.
52	3,064	Belgrade	89.26	89.26	96.0	18.0	2.5	Vincennes, Ind	Evansville, Ind.
53	3,376	Bellaire	124.75	116.77	127.3	24.2	3.6	Harmar, Ohio	Wheeling, W. Va.
54	3,228	Bella Israel	60.84	32.28	71.3	27.3	4.6	Berwick City, La	New Orleans, La.
55	3,119	Bella Mac	107.64	107.64	111.0	22.0	3.8	La Crosse, Wis	La Crosse, Wis.
56	3,170	Belle Crooks	78.43	78.43	91.0	22.0	3.0	Jeffersonville, Ind	New Orleans, La.
57	2,925	Belle McGowan	150.02	150.02	134.0	22.0	4.5	Pittsburgh, Pa	Pittsburgh, Pa.
58	3,113	Belle Prince	109.12	109.12	114.4	19.6	3.6	Freedom, Pa	Wheeling, W. Va.
59	3,125	Belle of Bowmansville.	102.44	102.44	110.0	30.1	4.0	Grafton, Ill	St. Joseph, Mo.
60	3,073	Belle of Chester	88.65	88.65	112.0	26.3	3.8	do	St. Louis, Mo.
61	3,130	Belle of the Coast	480.17	373.40	187.4	37.0	6.9	Cincinnati, Ohio	New Orleans, La.
62	3,390	Ben Hur	284.48	284.48	165.0	30.5	4.8	Harmar, Ohio	Wheeling, W. Va.
63	2,839	Ben Wood	143.69	143.69	122.0	23.0	5.0	Pittsburgh, Pa	Pittsburgh, Pa.
64	3,374	Bennett	192.02	192.02	134.4	26.2	3.6	Brownsville, Pa	Wheeling, W. Va.
65	2,957	Benton	394.68	394.68	197.0	23.0	5.0	Pittsburgh, Pa	Omaha, Nebr.
66	3,277	Benton McMillin	464.75	464.75	199.6	33.0	5.5	Jeffersonville, Ind	Cincinnati, Ohio.
67	3,146	Bessie F	87.21	87.21	106.0	26.0	3.6	Cincinnati, Ohio	Memphis, Tenn.
68	3,278	Bessie Siler	54.42	49.38	93.0	16.0	3.0	Harmar, Ohio	Wheeling, W. Va.

IV.—*List of merchant steam-boats navigating the Mississippi River*, etc.—Continued.

List No.	Official No.	Name.	Tonnage. Gross.	Tonnage. Net.	Length.	Breadth.	Depth.	Where built.	Home port.
			Tons.	*Tons.*	*Feet.*	*Ft.*	*Ft.*		
69	3, 033	Beta	78.15	78.15	116.0	22.0	3.5	Evansville, Ind	Vicksburg, Miss.
70	3, 382	Big Kanawha	212.54	212.54	152.0	30.0	4.5	Madison, Ind	Wheeling, W.Va.
71	3312	Bonanza	741.13	741.13	267.5	42.8	6 7	Cincinnati, Ohio	Cincinnati, Ohio.
72	3338	Birdie Bailey	109.74	109.74	111 0	22.0	3 5	Little Rock, Ark	Vicksburg, Miss.
73	2269	Birdie Brent	152.74	152.74	112.2	35.2	4.8	Jeffersonville, Ind.	Kansas City, Mo.
74	3363	Blanks Cornwell	232 40	232.40	140.0	29.0	4.0	do	Louisville, Ky.
75	120497	Blue Wing	111 82	111.82	119.0	24.0	4.2	Ashland, Ky	Do.
76	3188	Boaz	623 30	623.3	193.0	44.0	6.5	Pittsburgh, Pa	Pittsburgh, Pa.
77	2525	Bob Connell	123.00	123.00	105.0	19.0	4.0	do	Do.
78	3391	Bob Henry	80.24	55.44	91.4	16.6	2.4	Charleston, W.Va.	Wheeling, W. Va.
79	157087	Bob Pritchard	234.80	234.80	150.0	27.5	5.2	Mason City, W.Va.	Do.
80	3052	Boone	235.03	235.03	162.0	31.5	4.0	Mount Pleasant, W. Va.	Do.
81	3310	Border City	96.96	88.86	108.0	21.0	2.5	Fort Smith, Ark	Memphis, Tenn.
82	3028	Boston	70.77	57.10	65.0	16.0	2.5	Pittsburgh, Pa	Pittsburgh, Pa.
83	3109	Bostona	993.32	993.32	302.0	43.4	6.0	Cincinnati, Ohio	Cincinnati, Ohio.
84	2787	Bowling Green	301.90	183.57	121.7	28.8	5.9	Louisville, Ky	Evansville, Ind.
85	3309	Brazos	149.94	149.94	142.0	28.0	4.5	Galveston, Tex	New Orleans, La.
86	3403	Bright Star	71.52	41.66	89.6	18.7	2.8	Calico Rock, Ark	Memphis, Tenn.
87	2761	Brother Jonathan	110.23	110.23	110.6	21.0	4.0	Le Claire, Iowa	Galena, Ill.
88	2727	Buckeye	69.62	69.62	102.0	16.4	3.0	Reed's Landing, Minn.	La Crosse, Wis.
89	3356	Buckeye Boy	107.06	107.06	112.3	24.8	3.5	McConnelsville, Ohio.	Wheeling, W. Va.
90	3247	Buckeye State	669.92	669.92	252.3	39.8	6.8	Cincinnati, Ohio	Cincinnati, Ohio.
91	85724	Burnside	100.45	100.45	114.6	20.4	3.0	Harmar, Ohio	Wheeling, W. Va.
92	126472	C. Smith	333.69	226.39	132.0	29.0	3.5	Mound City, Ill	Paducah, Ky.
93	126236	C. A. Hill	69.62	69.62	119.5	21.3	3.6	Point Pleasant, W. Va.	Wheeling, W. Va.
94	126503	C. B. Bryan	330.44	238.75	114.2	29.0	4.5	Memphis, Tenn	Memphis, Tenn.
95	126066	C. C. Martin	67.78	67.78	103.2	18.3	2.9	Harmar, Ohio	Wheeling, W. Va.
96	4658	C. J. Caffrey	197.70	197.70	131.0	26.0	4.5	Rock Island, Ill	Burlington, Iowa.
97	125558	C. W. Anderson	184.46	184.46	161.0	31.8	4.8	Jeffersonville, Ind.	St. Louis, Mo.
98	125767	C. W. Batchelor	392.85	392.85	173.0	33.2	4.4	Brownsville, Pa	Wheeling, W. Va.
99	125929	C. W. Cowles	180.24	180.24	128.5	26.6	4.0	Madison, Ind	La Crosse, Wis.
100	4652	Cahokia	291.13	291.13	167.5	46.2	5.5	do	St. Louis, Mo.
101	125508	Calhoun	631.74	631.74	230.0	36.0	5.4	Jeffersonville, Ind.	Do.
102	125432	Campbell	267.28	267.28	167.0	34.6	5.6	St. Louis, Mo	Dubuque, Iowa.
103	126130	Caney Fork	83.90	83.90	126.0	19.0	2.0	Paducah, Ky	New Orleans, La.
104	126323	Cape City	72.64	72.64	98.4	29.4	4.0	Grafton, Ill	St. Louis, Mo.
105	126290	Capitola Butt	57.03	57.03	83.7	23.3	3.3	Montrose, Iowa	Omaha, Nebr.
106	126159	Carlos S. Greeley	403.38	403.38	160.7	48.5	6.4	Jeffersonville, Ind.	St. Louis, Mo.
107	125982	Carrie Hope	281.32	175.32	141.0	27.4	3.2	do	Louisville, Ky.
108	126055	Carrie M. Kraft	81.16	81.16	102.0	20.0	3.0	Parkersburgh, W. Va.	Memphis, Tenn.
109	126252	Carrier	140.88	140.88	165.4	26.4	4.0	Jeffersonville, Ind.	Mobile, Ala.
110	126079	Champion No. 2	52.16	52.16	76.0	22.8	3.4	Mason City, W. Va.	Wheeling, W. Va.
111	5984	Champion No. 8	210.18	210.28	131.0	28.0	5.2	Cincinnati, Ohio	Cincinnati, Ohio.
112	125960	Champion No. 10	134.31	134.31	130.7	23.2	3.6	do	Do.
113	125084	Chas. Brown	544.12	544.12	200.0	33.0	6.0	Pittsburgh, Pa	Pittsburgh, Pa.
114	125877	Chas. Jutte	107.11	107.11	115.0	22.0	3.5	do	Do.
115	126148	Chas. Merriam	515.46	515.46	206.0	45.0	6 5	Jeffersonville, Ind.	Memphis, Tenn.
116	126144	Chas. D. Shaw	186.03	186.03	132.0	24.0	4.0	do	Natchez, Miss.
117	126463	Charleston	78.58	70.25	94.9	25.6	4.0	Charleston, W.Va.	Wheeling, W. Va.
118	126061	Charlie Clark	147.69	147.69	131.0	23.6	4.3	Pittsburgh, Pa	Pittsburgh, Pa.
119	126037	Charlie De Pauw	142.24	142.24	125.0	23.3	4.0	Jeffersonville, Ind.	Louisville, Ky.
120	125934	Charlotte Boeckeler.	143.48	143.48	140.0	29.4	4.1	New Albany, Ind.	St. Louis, Mo.
121	126166	Chickasaw	733.90	568.84	186.0	39.0	5.9	Pittsburgh, Pa	Memphis, Tenn.
122	120315	Cincinnati	197.76	197.76	120.4	40.0	5.2	Cincinnati, Ohio	Cincinnati, Ohio.
123	4, 686	Cincinnati Belle	178.73	178.73	97.6	33.0	4.0	Cincinnati, Ohio	Do.
124	125, 395	City of Charleston	81.32	81.32	85.0	25.0	3.7	do	Wheeling, W. Va.
125	126, 400	City of Clarksville	235.20	194.60	125.0	24.0	3.5	Paducah, Ky	Paducah, Ky.
126	115, 902	City of Florence	358.31	358.31	160.0	32.0	5.3	Jeffersonville, Ind.	St. Louis, Mo.
127	5, 357	City of McGregor	64.58	64.58	100.0	36.0	3.6	Pittsburgh, Pa	Dubuque, Iowa.
128	126, 040	City of Madison	964.37	964.37	265.0	42 1	6.3	Madison, Ind	Cincinnati, Ohio.
129	126, 074	City of Newport	177.64	177.64	123.7	28.0	5.5	Cincinnati, Ohio	Do.
130	126, 329	City of Owensboro	714.87	664.93	245.0	27.6	6.3	Jeffersonville, Ind.	Louisville, Ky.
131	8, 965	City of St. Louis	224.09	224.09	160.0	32.0	6.0	Madison, Ind	St. Louis, Mo.
132	1, 494	City of St. Paul	180.00	180.00	126.0	18.8	5.4	Allegan, Mich	St. Paul, Minn.
133	125, 940	City of Vevay	339.54	339.54	190.8	36.4	5.1	Madison, Ind	Cincinnati, Ohio.
134	126, 010	City of Winona	147.64	147.64	126.2	25.5	3.5	Dubuque, Iowa	La Crosse, Wis.
135	125, 528	Clara	60.95	60.95	87.0	14.0	2.5	Leon, W. Va	Wheeling, W. Va.
136	125, 847	Claribell	71.48	56.66	100.0	18.8	2.0	Point Pleasant, W. Va.	Do.

IV.—*List of merchant steam-boats navigating the Mississippi River, etc.*—Continued.

List No.	Official No.	Name.	Tonnage.		Length.	Breadth.	Depth.	Where built.	Home port.
			Gross.	Net.					
137	126, 118	Clifton	280. 67	185. 67	133. 0	27. 8	4. 1	Pittsburgh, Pa	Wheeling, W. Va.
138	125, 013	Clinton	909. 22	909. 22	246. 9	38. 4	5. 7	St. Louis, Mo	New Orleans, La.
139	125, 086	Clyde	121. 20	121. 20	125. 0	19. 0	4 0	Dubuque, Iowa	Dubuque, Iowa.
140	125, 990	Clyde	578. 08	382. 96	181. 0	32. 5	5. 6	Jeffersonville, Ind.	Evansville, Ind.
141	5, 350	Coal City	361. 94	361. 94	170. 0	32. 4	4. 9	Pittsburgh, Pa	Pittsburgh, Pa.
142	5, 354	Coal Valley	352. 44	352. 44	152. 0	28. 9	6. 0	do	Do.
143	125, 676	Col. Hooker	87. 96	87. 96	112. 0	26. 0	3. 6	Gainesville, Miss	Vicksburg, Miss.
144	125, 976	Comet	100. 08	100. 08	114. 0	23. 0	3. 9	Pittsburgh, Pa	Cincinnati, Ohio.
145	4, 659	Commonwealth	1, 105. 05	1, 105. 05	255. 2	42. 2	6. 9	Shousetown, Pa	Do.
146	125, 846	Concordia	72. 71	72. 71	92. 0	25. 6	4. 6	Jeffersonville, Ind.	Natchez, Miss.
147	126, 080	Cora	75. 18	75. 18	105. 0	22. 0	2. 8	Pittsburgh, Pa	Cincinnati, Ohio.
148	126, 335	Corneal Goldman	172. 19	172. 19	143. 0	25. 1	6. 1	Jeffersonville, Ind.	Louisville, Ky.
149	125, 703	Corana	584. 20	338. 20	173. 0	36. 0	6 0	Cincinnati, Ohio	Do.
150	126, 171	Corozal	283. 28	283. 28	142. 8	30. 9	5. 9	do	New Orleans, La.
151	5, 929	Courier	494. 28	494. 28	193. 5	33. 0	5. 6	Harmar, Ohio	Cincinnati, Ohio.
152	120, 597	Crescent	82. 93	82. 93	106. 0	18. 0	3. 0	Letart Falls, Ohio.	New Orleans, La.
153	110, 511	Crown Hill	120. 83	120. 83	127. 0	19. 5	4. 0	Middleport, Ohio	Wheeling, W. Va.
154	126, 330	Crown Point	235. 20	159. 14	123. 0	25. 0	4. 2	Evansville, Ind	Evansville, Ind.
155	126, 229	Crusader	302. 07	186. 77	138. 8	22. 3	2. 9	Nashville, Tenn	Paducah, Ky.
156	105, 568	Cumberland	234. 79	234. 79	138. 0	26. 6	4. 0	Brownsville, Pa	Vicksburgh, Miss.
157	6, 944	D. Steine	110. 17	110. 17	124. 4	25. 8	3. 5	Cincinnati, Ohio	New Orleans, La.
158	157, 182	D. A. Brooks, jr	70. 40	54. 08	75. 5	17. 0	3. 5	Caseyville, Ky	Paducah, Ky.
159	157, 072	D. C. Fogel	89. 69	89. 69	121. 9	21 6	4. 4	Cincinnati, Ohio	New Orleans, La.
160	6, 760	D. T. Lane	146. 94	146. 94	129. 6	24. 1	4. 0	Pittsburgh, Pa	Cincinnati, Ohio.
161	1, 356	D. T. Watson	80. 45	80. 45	99. 0	17. 0	2. 6	do	Pittsburgh, Pa.
162	6, 982	Dacotah	956. 98	956. 98	252. 0	48. 3	5. 5	do	St. Louis, Mo.
163	157, 199	Daisy	106. 64	106. 64	122. 0	22. 0	3. 8	Stillwater, Minn	St. Paul, Minn.
164	157, 012	Danton	56. 25	28. 13	173. 8	20. 8	3. 8	Berwick, La	Brashear, La.
165	6, 941	Danube	250. 32	232. 32	175. 0	33. 8	5. 1	Cincinnati, Ohio	New Orleans, La.
166	75, 829	Dave Wood	143. 57	143. 57	130. 8	22. 0	4 0	Pittsburgh, Pa	Pittsburgh, Pa.
167	76, 076	David Bronson	153. 41	153. 41	130. 0	24. 0	4. 3	Stillwater, Minn	St. Paul, Minn.
168	157, 172	Dayton	357. 49	195. 63	142. 0	24. 7	3. 6	Kingston, Tenn	Chattanooga, Tenn.
169	6, 783	Delia No. 2	67. 06	67. 06	89. 4	18. 6	4. 3	Cincinnati, Ohio	New Orleans, La.
170	3, 153	Delta	86. 64	86. 64	110. 0	22. 5	4. 0	Pittsburgh, Pa	Pittsburgh, Pa.
171	6, 933	Delver	96. 61	96. 61	137. 2	27. 0	3. 5	Jeffersonville, Ind.	St. Louis, Mo.
172	85, 504	De Soto	881. 27	881. 27	261. 0	41. 8	6. 6	Cincinnati, Ohio	Cincinnati, Ohio.
173	6, 973	Dick Fulton	357. 53	357. 53	170. 0	31. 0	5. 5	Pittsburgh, Pa	Pittsburgh, Pa.
174	157, 086	Dixie	110. 78	68. 33	80. 0	19. 0	3. 2	Chattanooga, Tenn	Chattanooga, Tenn.
175	157089	Dixie	74. 96	74. 96	79. 1	17. 4	3. 4	Batesville, Miss	Memphis, Tenn.
176	6679	Dr. Frederick Hill	160. 24	160. 24	140. 4	36. 8	4. 0	Metropolis, Ill	St. Louis, Mo.
177	6766	Dolphin	156. 16	156. 16	135. 8	22. 8	4. 8	Jeffersonville, Ind	Do.
178	157009	Dora	392. 23	392. 23	199. 5	25. 2	4. 3	Metropolis, Ill	Do.
179	157083	Dora	81. 08	81. 08	90. 9	20. 0	3. 6	Boeger's Landing Mo.	Do.
180	157034	Douglas Boardman.	182. 87	182. 87	120. 0	32. 0	4. 0	Dubuque, Iowa	Galena, Ill.
181	80688	Duquesne	128. 02	128. 02	109. 0	20. 5	3. 3	Clarington, Ohio	Pittsburgh, Pa.
182	157194	Dyersburg	73. 08	73. 08	93. 0	18. 4	3. 0	Dyersburgh, Tenn	Memphis, Tenn.
183	135942	E. G. Ragon	309. 99	309. 99	165. 0	31. 0	5. 0	Jeffersonville, Ind.	Nashville, Tenn.
184	135426	E. H. Barman	171. 47	171. 47	135. 7	30. 1	5. 4	do	Brashear, La.
185	135109	E. M. Norton	549. 53	549. 53	174. 0	30 5	6. 0	Middleport, Ohio	St. Louis, Mo.
186	135961	E. T. Holman	102. 48	71. 59	100. 0	20. 0	3. 0	Nashville, Tenn	Paducah, Ky.
187	135424	E. W. Cole	487. 91	487. 91	201. 0	31. 0	5. 4	Jeffersonville, Ind	Brashear, La.
188	135443	Eagle	185. 01	185. 01	140. 0	24. 5	4. 8	Pittsburgh, Pa	Pittsburgh, Pa.
189	135674	Eagle	231. 30	227. 78	155. 6	24. 8	4. 2	Grafton, Ill	St. Louis, Mo.
190	135773	Earl	130. 07	120. 14	116. 0	28. 7	5. 1	Gainesville, Miss	New Orleans, La.
191	8256	East St. Louis	397. 49	397. 49	178. 0	51. 4	6. 4	Louisville, Ky	St. Louis, Mo.
192	135861	Edith	69. 59	69. 59	101. 0	24. 0	3. 1	Mason, W. Va	Do.
193	95518	Edna Adams	219. 47	149. 37	111. 6	24. 0	3. 1	Evansville, Ind	Evansville, Ind.
194	135993	Ed. Davison	92. 91	92. 91	122. 0	25. 0	4. 1	Pittsburgh, Pa	Pittsburgh, Pa.
195	135328	Ed. Foster	243. 01	164. 67	100. 0	26. 5	4. 0	Cincinnati, Ohio	Louisville, Ky.
196	135781	Ed. Roberts	253. 89	253. 89	171. 6	16. 0	4. 0	Madison, Ind	Pittsburgh, Pa.
197	7579	Edwardsville	277. 08	277. 08	166. 3	41. 8	5. 9	Carondelet, Mo	St. Louis, Mo.
198	135591	Elaine	158. 10	158. 10	142. 5	25. 0	3. 4	Wheeling, W. Va	Wheeling, W. Va.
199	135923	Eli	140. 25	120. 25	106. 0	21. 5	2. 5	Little Rock, Ark	Memphis, Tenn.
200	135981	Elizabeth	340. 18	284. 02	166. 0	26. 0	5. 6	Pittsburgh, Pa	Pittsburgh, Pa.
201	135492	Ella	284. 70	184. 70	148. 0	28. 0	2. 5	Jeffersonville, Ind.	Memphis, Tenn.
202	135538	Ella	94. 29	71. 75	88. 0	18. 0	3. 6	Kansas City, Mo	Brashear, La.
203	135079	Ella Layman	119. 08	119. 08	123. 0	23. 0	4. 2	Pittsburgh, Pa	Wheeling, W. Va
204	135461	Emma	90. 86	90. 89	102. 0	32. 5	6. 0	Algiers, La	New Orleans, La.
205	120345	Emma Cooper	259. 97	178. 07	95. 0	25. 0	3. 5	Pittsburgh, Pa	Evansville, Ind.
206	135425	Emma Uhl	59. 71	59. 71	72. 9	18. 0	3. 8	Marietta, Ohio	Wheeling, W. Va.
207	110344	Enquirer	111. 29	84. 89	153. 2	17. 8	5. 6	Covington, Ky	Cincinnati, Ohio.
208	135080	Enterprise	226. 32	226. 32	150. 0	27. 0	5. 0	Pittsburgh, Pa	Pittsburgh, Pa.
209	8910	Enterprise No. 2	71. 42	71. 42	80. 3	26. 4	3. 8	Cincinnati, Ohio	Evansville, Ind.
210	8370	Era No. 10	176. 89	176. 89	136. 0	30. 8	5. 0	Madison, Ind	New Orleans, La.

IV.—*List of merchant steam-boats navigating the Mississippi River, etc.*—Continued.

List No.	Official No.	Name.	Tonnage.		Length.	Breadth.	Depth.	Where built.	Home port.
			Gross.	Net.					
			Tons.	*Tons.*	*Feet.*	*Ft.*	*Ft.*		
211	135715	Eugene	98.31	98.31	113.7	20.0	3.5	Brownsville, Pa	Evansville, Ind.
212	135955	Eugene	570.05	508.85	176.0	34.0	4.4	Pittsburgh, Pa	Memphis, Tenn.
213	8626	Evansville	158.60	158.60	109.2	26.0	3.9	Evansville, Ind	Galena, Ill.
214	135569	Evansville	194.24	194.24	121.0	30.2	5.0	Cincinnati, Ohio	Evansville, Ind.
215	135501	Excel	118.90	118.90	122.0	21.5	3.5	Brownsville, Pa	Cincinnati, Ohio.
216	135778	Experiment	62.35	34.99	106.5	16.2	3.0	Evansville, Ind	Evansville, Ind.
217	120600	F. Barksdale	216.67	216.67	155.0	30.5	5.4	Jeffersonville, Ind.	Vicksburg, Miss.
218	120642	F. D. Underwood	126.97	126.97	116.0	22.0	5.0	Big Stone City, Dak	St. Paul, Minn.
219	120224	Fanchon	478.14	254.03	174.0	35.0	4.7	Brownsville, Pa	St. Louis, Mo.
220	120490	Fannie	150.93	80.09	85.4	18.4	3.7	Cairo, Ill.	Evansville, Ind.
221	120407	Fawn	73.00	73.00	91.9	19.1	3.4	St. Louis, Mo	St. Louis, Mo.
222	120419	Fleetwood	1,036.60	1,036.60	302.2	43.4	6.4	Cincinnati, Ohio	Cincinnati, Ohio.
223	22667	Flying Eagle	373.82	373.82	156.0	35.0	5.0	Brownsville, Pa	St. Louis, Mo.
224	120570	Frank Gilmore	243.62	160.02	135.0	24.3	4.3	Pittsburgh, Pa	Pittsburgh, Pa.
225	9735	Frank McHarry	146.60	146.60	125.5	34.5	4.2	New Albuny, Ind	Louisville, Ky.
226	120604	Frank Preston	61.14	61.14	103.5	19.3	2.9	Catlettsburgh, Ky.	Cincinnati, Ohio.
227	120549	Frank Stein	150.61	150.61	138.6	25.0	3.1	Belle Vernon, Pa	Evansville, Ind.
228	120335	Frank S. Owens	65.43	65.43	93.0	24.0	3.2	Cincinnati, Ohio	Wheeling, W. Va.
229	120703	Fred. Nellis	70.26	57.17	96.0	19.0	4.0	Jeffersonville, Ind	Paducah, Ky.
230	120567	Fred. Wilson	533.82	408.98	174.0	30.8	5.4	Pittsburgh, Pa	Pittsburgh, Pa.
231	120536	Frederick	82.51	82.51	96.4	14.3	3.0	St. Louis, Mo	St. Louis, Mo.
232	120070	Future City	589.30	589.30	187.4	36.0	6.1	Cincinnati, Ohio	Do.
233	10703	G. B. Knapp	139.08	130.08	130.0	20.0	4.0	Osceola, Wis	St. Paul, Minn.
234	85901	G. B. Monteith	69.03	62.91	103.4	18.2	2.0	Long Reach, W. Va	Wheeling, W. Va.
235	85692	G. H. Van Etten	119.30	119.30	130.0	24.0	2.0	Little Rock, Ark	Memphis, Tenn.
236	85693	G. W. Anderson	92.70	79.01	81.0	22.0	3.0	Franklin, La	Brashear, La.
237	85987	G. W. Mayo	136.96	99.76	80.9	20.2	2.8	Fort Smith, Ark	Memphis, Tenn.
238	95725	G. W. Sentall	306.76	306.76	160.0	29.5	4.8	Jeffersonville, Ind.	St. Louis, Mo.
239	85720	Gardie Eastman	100.29	100.29	111.1	20.7	3.5	Sebewaing, Mich	Galena, Ill.
240	85909	Gate City	109.44	109.44	125.0	25.7	4.5	Madison, Ind	Cincinnati, Ohio.
241	85803	Gayaso	197.07	197.07	127.3	28.0	4.8	Brownville, Pa	Memphis, Tenn.
242	85854	Gem City	580.56	551.26	263.0	29.8	5.6	St. Louis, Mo	St. Louis, Mo.
243	85830	General Dawes	122.58	119.62	119.0	26.0	3.3	Harmar, Ohio	Wheeling, W. Va.
244	125381	General Meade	171.46	171.46	192.0	30.0	4.3	Pittsburgh, Pa	St. Louis, Mo.
245	85567	General Miles	72.45	72.45	95.2	17.3	2.1	St. Louis, Mo	Vicksburg, Miss.
246	85491	General Pike	411.79	411.79	220.0	34.7	5.2	Madison, Ind	Cincinnati, Ohio.
247	85628	General H. F. Devol.	156.99	156.99	130.0	22.5	3.8	Harmar, Ohio	Wheeling, W. Va.
248	85537	General Chas. H. Thompkins.	356.55	356.55	183.0	25.5	3.8	Pittsburgh, Pa	St. Louis, Mo.
249	85468	George Baker	69.94	69.94	90.7	18.0	3.0	do	Memphis, Tenn.
250	85242	George Lysle	426.74	426.74	174.0	33.0	6.0	do	St. Louis, Mo.
251	85548	George Matheson	105.72	105.72	112.0	22.0	4.0	do	Cincinnati, Ohio.
252	85239	George Roberts	135.45	135.45	125.5	23.0	4.4	do	Pittsburgh, Pa.
253	140047	George Shivas	140.27	140.27	131.0	22.0	4.0	do	Do.
254	85635	George Strecker	154.75	154.75	127.6	23.8	2.9	Long Reach, W. Va.	Evansville, Ind.
255	85981	George Wood	292.32	220.02	143.0	27.7	4.9	Pittsburgh, Pa	Pittsburgh, Pa.
256	85820	George N. Stockton	53.67	53.67	86.0	17.5	3.5	La Fayette, Ind	Evansville, Ind.
257	85917	George R. Ford	188.41	138.41	121.6	24.0	4.0	Pittsburgh, Pa	Pittsburgh, Pa.
258	85907	George W. Decker	174.17	174.17	133.0	26.4	4.5	Black Rock, Ark	Memphis, Tenn.
259	75467	George W. Stone	106.50	106.50	124.0	20.5	3.5	Pittsburgh, Pa	Pittsburgh, Pa.
260	85529	Germania	339.06	339.06	163.0	32.0	5.5	do	Do.
261	85873	Gertie Pool	98.44	56.03	90.0	22.0	3.0	Evansville, Ind	Evansville, Ind.
262	85878	Glenmont	92.16	92.16	128.0	24.6	4.6	Dubuque, Iowa	La Crosse, Wis.
263	105194	Glenwood	91.50	91.50	112.0	19.0	3.9	Pittsburgh, Pa	Pittsburgh, Pa.
264	85821	Gondola	183.23	125.44	118.2	23.7	3.5	do	Paducah, Ky.
265	85739	Grace Morris	195.91	125.64	101.5	20.0	3.8	Evansville, Ind	Louisville, Ky.
266	85902	Grace Velie	58.50	53.22	80.0	17.9	3.4	Jeffersonville, Ind.	Memphis, Tenn.
267	85583	Granite State	531.11	531.11	221.0	35.6	5.7	Cincinnati, Ohio	Cincinnati, Ohio.
268	85413	Gretna Green	120.22	120.22	91.3	27.0	3.6	do	Do.
269	85624	Gus. Fowler	309.62	309.62	160.0	29.5	5.6	Jeffersonville, Ind.	Paducah, Ky.
270	85686	Gus. Genin	130.09	130.09	120.0	20.0	4.0	Ironton, Ohio	Wheeling, W. Va.
271	95556	H. A. Mead	67.52	67.52	90.0	26.5	3.7	do	Cincinnati, Ohio.
272	95890	H. B. Sinclair	85.96	76.70	88.0	24.1	5.4	Pittsburgh, Pa	Pittsburgh, Pa.
273	95388	H. E. Pierrepont	81.53	81.53	102.0	20.0	4.0	Brownsville, Pa	Do.
274	95863	H. F. Frisbie	270.45	270.45	169.4	32.2	5.8	Cincinnati, Ohio	Cincinnati, Ohio.
275	95643	H. J. Dickey	455.89	208.54	167.0	36.0	6.0	Memphis, Tenn	New Orleans, La.
276	95856	H. K. Bedford	139.68	139.68	149.0	27.7	4.1	Jeffersonville, Ind.	Nashville, Tenn.
277	95701	H. M. Townsend	89.70	89.70	116.7	18.0	3.1	Wheeling, W. Va	Wheeling, W. Va.
278	95622	H. Hanna Blanks	352.75	352.75	155.4	34.5	5.5	Cincinnati, Ohio	Louisville, Ky.
279	95928	Hallette	265.90	265.90	161.0	30.5	4.5	Jeffersonville, Ind.	New Orleans, La.
280	95247	Handy	99.77	99.77	110.3	21.6	3.0	Cincinnati, Ohio	Wheeling, W. Va.
281	95902	Harry S	138.14	138.14	132.7	29.0	4.0	Wolf Creek, Ky	Louisville, Ky.
282	95580	Harry Brown	772.15	772.15	210.0	49.6	6.0	Pittsburgh, Pa	Pittsburgh, Pa.
283	95076	Harry Higbee	90.77	90.77	106.7	28.4	3.4	Evansville, Ind	Cincinnati, Ohio.

IV.—*List of merchant steam-boats navigating the Mississippi River, etc.*—Continued.

List No.	Official No.	Name.	Tonnage.		Length.	Breadth.	Depth.	Where built.	Home port.
			Gross.	Net.					
			Tons.	*Tons.*	*Feet.*	*Ft.*	*Ft.*		
284	95766	Harry D. Knox	91.84	85.09	117.0	20.6	3.4	Harmar, Ohio	Wheeling, W. Va.
285	95687	Hartford	91.01	91.01	114.0	22.4	4.8	Wabasha, Minn	La Crosse, Wis.
286	95796	Hattie Brown	58.11	58.11	120.0	20.3	3.1	Belle Vernon, Pa	Cincinnati, Ohio.
287	11726	Hawk	141.28	141.28	118.0	20.0	4.0	Pittsburgh, Pa	Wheeling, W. Va.
288	95957	Hazel	78.30	53.48	84.0	37.0	5.0	Lake Charles, La	Lake Charles, La.
289	95843	Helen Mead	82.37	82.37	112.1	20.1	4.2	Charleston, W. Va.	Vicksburg, Miss.
290	95297	Helene Schulenberg.	107.95	107.95	130.3	25.4	3.7	Metropolis, Ill	St. Louis, Mo.
291	95762	Henry DeBus	193.45	193.45	143.3	28.3	5.4	Covington, Ky	Cincinnati, Ohio.
292	95660	Henry Lowrey	646.79	646.79	209.6	35.2	5.3	Mound City, Ill	St. Louis, Mo.
293	95780	Henry Marx	357.35	199.57	138,0	30.0	4.5	Evansville, Ind	New Orleans, La.
294	95770	Henry Sackman	600.04	600.04	254.0	48.0	6.0	Jeffersonville, Ind	St. Louis, Mo.
295	95904	Herbert	316.26	167.60	134.0	27.0	3.0	Cincinnati, Ohio	Chattanooga, Tenn.
296	95557	Hettie	176.75	176.75	124.0	49.3	6.6	....do	New Orleans, La.
297	95865	Hettie Mason	113.94	56.70	86.0	20.5	2.5	Empire Landing, Ill.	Paducah, Ky.
298	95636	Hibernia	157.06	157.06	135.0	25.0	4.0	Rock Castle, W. Va.	Louisville, Ky.
299	95372	Hiram B	50.53	50.53	76.8	17.0	4.4	Wheeling, W. Va.	Cincinnati, Ohio.
300	95496	Hope	54.11	54.11	107.0	20.0	3.5	New Albany, Ind.	Kansas City, Mo.
301	95654	Horace	66.79	66.79	90.0	18.0	3.0	Murraysville, W. Va.	Wheeling, W. Va.
302	95612	Hornet	238.36	238.36	130.0	27.0	5.4	West Point, Ky	New Orleans, La.
303	95188	Hornet No 2	289.05	289.05	156.0	28.0	5.5	Pittsburgh, Pa	Pittsburgh, Pa.
304	95393	Hotspur	89.37	89.37	110.0	22.4	3.5	Evansville, Ind	Louisville, Ky.
305	95878	Hudson	741.76	620.07	223.3	37.6	6.3	Pittsburgh, Pa	St. Louis, Mo.
306	95840	Hugh Barr	66.26	33.26	70.4	18.5	3.6	Tom's Hill, Ind	Evansville, Ind.
307	95621	Huston Combs No. 2.	95.96	95.96	98.0	22.0	3.4	Bowling Green, Ky.	Cincinnati, Ohio.
308	100373	I. N. Bunton No. 2.	195.06	142.56	131.0	28.4	4.0	Pittsburgh, Pa	Pittsburgh, Pa.
309	76346	Ida Budd	151.90	151.90	121.9	26.2	4.6	Cincinnati, Ohio	Cincinnati, Ohio.
310	100267	Ida Lee	99.23	99.23	110.0	22.5	3.0	Pittsburgh, Pa	Evansville, Ind.
311	100300	Ida B. Cothell	57.05	57.05	92.7	22.1	3.7	New Orleans, La	New Orleans, La.
312	105844	Idlewild	520.36	520.36	207.6	35.6	5.7	Cincinnati, Ohio	Evansville, Ind.
313	100231	Ike Bonham	78.52	78.52	93.4	18.0	3.6	Wheeling, W. Va	Vicksburg, Miss.
314	140724	Independent	116.94	70.40	114.0	16.3	3.6	Ashland, Ky	Cincinnati, Ohio.
315	100324	Ingomar	74.61	74.61	111.0	19.5	3.0	Harmar, Ohio	Do
316	100418	Inverness	121.92	121.92	121.0	21.0	4.8	La Crosse, Wis	La Crosse, Wis.
317	12155	Iowa	73.56	73.56	126.0	20.0	3.7	Savanna, Ill	Galena, Ill.
318	100283	Iron Cliff	302.31	154.57	132.0	24.0	4.0	Pittsburgh, Pa	Cincinnati, Ohio.
319	100285	Iron Duke	421.25	421.25	177.0	32.6	6.0	.....do	Pittsburgh, Pa.
320	100054	Ironsides	282.80	282.80	154.0	30.0	6.4	.....do	Do
321	100215	Isabel	69.37	69.37	80.5	20.0	3.9	Shawano, Wis	St. Louis, Mo.
322	76268	J. A. Woodson	219.78	219.78	42.0	30.0	3.0	Louisville, Ky	Memphis, Tenn.
323	75531	J. C. Abbott	65.80	65.80	90.0	28.0	3.6	Madison, Ind	Louisville, Ky.
324	76527	J. C. Kerr	121.15	121.15	120.0	21.0	3.7	Chambersburgh, Ohio.	Cincinnati, Ohio.
325	75318	J. C. McMullen	423.23	423.23	185.0	44.2	6.4	Mound City, Ill	St. Louis, Mo.
326	75707	J. C. Risher	148.83	148.83	134.0	22.0	4.0	Pittsburgh, Pa	Pittsburgh, Pa.
327	76384	J. C. Warner	201.05	201.05	142.0	31.6	4.6	Chattanooga, Tenn.	Chattanooga, Tenn.
328	76615	J. D. Carter	82.21	45.98	73.0	18.0	2.8	Nashville, Tenn	Paducah, Ky.
329	75694	J. F Joy	136.64	136.64	145.0	32.0	5.0	Madison, Ind	Dubuque, Iowa.
320	76217	J. G. Chapman	146.95	106.95	141.0	28.0	4.0	Metropolis, Ill	St. Louis, Mo.
331	76341	J. H. Hillman	281.68	281.68	149.0	28.5	3.7	Jeffersonville, Ind	Paducah, Ky.
332	75950	J. H. McConnell	138.07	138.07	117.9	20.0	3.7	Harmar, Ohio	Wheeling, W. Va.
333	76687	J. L. Stephens	85.95	85.95	103.0	29.4	4.2	Jeffersonville, Ind	Kansas City, Mo.
334	76299	J. M. Bowell	107.91	107.91	115.0	23.0	3.0	Pittsburgh, Pa	Pittsburgh, Pa.
335	76251	J. M. Clark	98.11	98.11	115.0	18.0	4.0	Ironton, Ohio	Do.
336	76234	J. P. Drouillard	467.17	467.17	165.0	51.0	5.0	Jeffersonville, Ind	Paducah, Ky.
337	76487	J. P. Gage	198.31	198.31	114.0	32.0	5.0	Clinton, Iowa	Galena, Ill
338	76713	J. R. Hughes	186.15	95.15	96.1	17.0	3.5	Kingston, Tenn	Chattanooga, Tenn.
339	75485	J. S. Mercer	164.80	164.80	140.0	24.0	4.5	Pittsburgh, Pa	Pittsburgh, Pa.
340	115517	J. S. Neel	150.10	150.10	125.0	22.0	4.0	....do	Do.
341	75563	J. W. Mills	86.98	86.98	109.7	22.2	3.0	Paducah, Ky	Galena, Ill.
342	76182	Jack Frost	350.77	350.77	165.0	30.0	5.4	Jeffersonville, Ind	St. Louis, Mo.
343	75764	J. Haetherington	192.77	192.77	128.8	24.0	4.2	Industry, Pa	Wheeling, W. Va.
344	75459	James Gilmore	214.80	214.80	145.0	23.0	5.1	Pittsburgh, Pa	Pittsburgh, Pa.
345	75970	James Guthrie	732.46	732.46	244.0	37.5	5.8	Jeffersonville, Ind	Louisville, Ky.
246	75466	J. A. Blackmore	109.96	109.96	118.0	22.0	4.3	Pittsburgh Bay, Pa	Pittsburgh, Pa.
347	76293	James G. Blaine	297.83	297.83	162.0	34.0	4.0	.. do	Do.
348	76505	Jas. R. Skiles	82.86	41.43	68.0	17.9	3.1	Bowling Green, Ky	Paducah, Ky.
349	76174	Jay Gould	446.25	446.25	186.8	30.4	6.0	Mound City, Mo	St. Louis, Mo.
350	13043	Jennie Brown	189.87	189.87	137.0	23.6	4.5	Louisville, Ky	La Crosse, Wis.
351	76232	Jennie Campbell	225.06	225.06	144.0	26.0	4.0	Brownsville, Pa	Cincinnati, Ohio.

IV.—*List of merchant steam-boats navigating the Mississippi River, etc.*—Continued.

List No.	Official No.	Name.	Tonnage.		Length.	Breadth.	Depth.	Where built.	Home port.
			Gross.	Net.					
			Tons.	*Tons.*	*Feet.*	*Ft.*	*Ft.*		
352	75925	Jennie Gilchrist	74.48	74.48	100.5	18.5	3.8	Le Claire, Iowa	Kansas City, Mo.
353	76083	Jennie Hayes	87.07	87.07	117.4	14.5	3.6	Franconia, Minn	Galena, Ill.
354	76102	Jesse K. Bell	921.60	921.60	219.4	41.0	6.9	Jeffersonville, Ind	New Orleans, La.
355	75247	Jessie	68.47	68.47	120.0	20.0	3.4	Parkersburgh, W. Va.	Wheeling, W. Va.
356	76663	Jessie Berger	78.46	78.46	110.6	24.6	3.7	Brownsville, Pa	Do.
357	76728	Jessie Wilson	120.30	71.70	81.5	20 0	3.8	Golconda, Ill	Evansville, Ind.
358	76029	Jewell	237.92	237.92	177.2	33.0	5.0	Jeffersonville, Ind.	New Orleans, La.
359	76250	Jim Brown	153.40	153.40	135.0	24.3	4.0	Pittsburgh, Pa	Pittsburgh, Pa.
360	76460	Jimmie B	58.32	58.32	97.3	20.0	2.3	Point Pleasant, W. Va.	Vicksburg, Miss.
361	76680	Joe Long	130.22	130.32	120.0	22.0	4.4	Stillwater, Minn	Galena, Ill.
362	100342	Joe Peters	525.90	426.30	177.2	34.4	4.8	Pittsburgh, Pa	Memphis, Tenn.
363	130208	John R	129.25	129.25	122.7	19.7	4.4	Murrayville, Ohio	Wheeling, W. Va.
364	76724	John Dana	227.64	227.64	153.2	30.7	4.4	Madison, Ind	Cincinnati, Ohio.
365	76661	John Fowler	237.89	237.89	147.5	28.5	3.5	Jeffersonville, Ind.	Paducah, Ky.
366	76612	John Gaston	206.27	206.27	148.0	32.0	4.0	Memphis, Tenn	Memphis, Tenn.
367	76280	John Gilbert	647.39	647.39	220.0	44.0	6.0	Pittsburgh, Pa	Evansville, Ind.
368	75464	John Gilmore	503.09	503.09	183.0	34.0	6.0	do	St. Louis, Mo.
369	75356	John Howard	485.37	329.69	180.0	36.0	6.0	Jeffersonville, Ind.	Louisville, Ky.
370	75469	John Penny	255.92	255.92	148.0	27.0	5.4	Pittsburgh, Pa	Pittsburgh, Pa.
371	76179	John Trendley	365.61	365.61	205.4	36.6	5.8	Madison, Ind	St. Louis, Mo.
372	75461	John A. Wood	687.52	687.52	198.0	40.0	7.0	Pittsburgh, Pa	Pittsburgh, Pa.
373	76176	John C. Fisher	156.45	156.45	133.0	25.0	3.4	do	Do
374	76187	John D. Lewis	266.41	266.41	148.2	28.2	4.0	Cincinnati, Ohio	Wheeling, W. Va.
275	76048	John D. Sculley	536.01	285.70	215.0	34.6	4.5	Pittsburgh, Pa	New Orleans, La.
376	76545	John F. Allen	133.90	133.90	130.2	24.0	4.2	Cincinnati, Ohio	Vicksburg, Miss.
377	75462	John F. Walton	485.04	463.04	177.0	34.0	6.5	Pittsburgh, Pa	Pittsburgh, Pa.
378	75900	John H. Hanna	377.18	377.18	181.2	38.0	6.5	Madison, Ind	Louisville, Ky.
379	76019	John H. Johnson	169.90	119.90	141.2	23.9	4.2	Louisville, Ky	Chattanooga, Tenn
380	76643	John J. Brown	89.08	89.08	115.0	25.3	4.8	Jeffersonville, Ind.	New Orleans, La.
381	76300	John K. Davison	89.20	89.20	122.6	27.0	3.3	Pittsburgh, Pa	Pittsburgh, Pa.
382	76407	John M. Abbott	97.78	97.78	92.0	20.0	3.6	Madison Ind	Burlington, Iowa.
383	76028	John P. Thorn	120.78	120.78	120.0	23.5	3.2	Pittsburgh, Pa	Pittsburgh, Pa.
384	76175	John S. Hopkins	752.54	490.12	200.0	35.3	6.0	do	Evansville, Ind.
385	72975	Joseph Nixon	307.71	307.71	163.5	26.8	5.0	do	Pittsburgh, Pa.
386	75708	Joseph Walson	300.27	300.27	158.0	27.0	5.0	do	Do.
387	75486	Joseph A. Stone	239.96	239.96	144.0	28.0	5.0	do	Do.
388	75866	Jos. B. Williams	801.91	801.91	210.0	40.0	6.5	do	Do.
389	75976	Joseph W. Gould	134.90	134.90	125.0	23.0	4.5	do	Do.
390	76060	Josephine Spengler.	104.50	104.50	106.0	25.0	3.0	Vicksburg, Miss	New Orleans, La.
391	75902	Josh. Cook	384.59	384.59	165.0	30.0	5.0	Pittsburgh, Pa	Pittsburgh, Pa.
392	75510	Josie	237.51	233.70	146.2	28.6	4.8	Madison, Ind	Dubuque, Iowa.
393	76602	Josie W	156.40	156.40	140.9	30.4	4.8	Belle Vernon, Pa	Louisville, Ky.
394	76712	Josie D. Harkins	73.13	73.13	110.0	19.5	3.3	Ward City, Ky	Cincinnati, Ohio.
395	76277	Judelle	119.08	119.08	100.0	25.0	3.4	Madison, Ind	Evansville, Ind.
396	130195	Judith	685.23	499.49	184.4	33.2	4.4	Mound City, Ill	St. Louis, Mo.
397	76133	Julian Gracey	81.71	81.71	100.0	22.0	2.8	Clarksville, Tenn	Paducah, Ky.
398	75815	Junius S. Morgan	438.83	438.83	195.0	44.5	7.0	Jeffersonville, Ind.	Do.
399	14159	Kangaroo	103.75	103.75	100.0	19.0	4.1	Pittsburgh Pa	Pittsburgh, Pa.
400	14294	Kate Waters No. 2	165.83	165.83	126.6	24.2	4.0	Cincinnati, Ohio	Cincinnati, Ohio.
401	14430	Katie Robbins	162.54	162.54	141.0	28.0	4.9	Jeffersonville, Ind.	Vicksburgh, Miss.
402	14360	Katie Stockdale	479.66	479.66	225.6	35.0	5.0	Pittsburgh, Pa	Pittsburgh, Pa.
403	14377	Kenton	153.08	153.08	105.2	33.4	5.2	Cincinnati, Ohio	Cincinnati, Ohio.
404	125503	Keokuk	348.69	348.69	211.2	36.4	4.8	Mound City, Ill	New Orleans, La.
405	14341	Key City	94.36	94.36	100 0	25.0	4.4	Dubuque, Iowa	Dubuque, Iowa.
406	20393	Kissimmee	188.88	110.21	110.2	19.7	6.2	Northport, N. Y	Pittsburgh, Pa.
407	76376	L. H. Sargent	85.46	85.46	116.2	22.4	4.3	Mason City, W. Va	Wheeling, W. Va.
408	15985	La Fayettee Lamb	118.21	118.21	100.0	22.0	3.6	Clinton, Iowa	Galena, Ill.
409	140473	Lady Grace	189.37	189.37	134.5	28.4	4.6	Clinton, Iowa	Do.
410	140401	Lady Jenks	98.22	98.22	115.5	24.3	3.8	New Albany, Ind	Louisville, Ky.
411	140733	Lake Washington	96.39	96.39	102.0	24.0	4.3	Madison, Ind	Vicksburg, Miss.
412	140851	Lancaster	156.09	156.09	135.6	23.5	3.8	Harmar, Ohio	Cincinnati, Ohio.
413	140361	Lark	65.83	43.29	70.0	14.0	3.0	Orange, Tex	Brashear, La.
414	15653	Last Chance	50.47	50.47	98.2	17.8	3 0	Burlington, Iowa	Omaha, Nebr.
415	140331	Laura Lee	377.90	377.90	209.0	37.4	6.1	Louisville, Ky	New Orleans, La.
416	140927	Lela	92.07	63.27	70.0	18.0	3.0	Ford's Ferry, Ky	Paducah, Ky.
417	140919	Leroy	66.44	48.17	60.0	14.0	2.7	Greenville, Miss	Memphis, Tenn.
418	15708	Lewis V. Bogy	227.80	227.80	167.6	36 0	5.0	Madison, Ind	St. Louis, Mo.
419	140318	Libbie Congor	324.09	319.00	168.0	29.5	4.5	Dubuque, Iowa	Dubuque, Iowa.
420	115752	Lillian	91.75	91.75	124.5	21.3	3.0	Ashland, Ky	Wheeling, W. Va.
421	140355	Lillie Low	58.22	31.58	111.5	20.3	4.0	Aberdeen, Miss	New Orleans, La.
422	140612	Lily Turner	154.22	115.68	110.0	18.0	3.8	Dubuque, Iowa	Galena, Ill.
423	140686	Line Hanson	54.95	54.95	82.5	18.5	3.5	Savanna, Ill	Do.
424	140022	Lion	71.96	71.96	100.0	15.6	3.0	Lyons, Iowa	La Crosse, Wis.

IV.—*List of merchant steam-boats navigating the Mississippi River, etc.*—Continued.

List No.	Official No.	Name.	Tonnage.		Length.	Breadth.	Depth.	Where built.	Home port.
			Gross.	Net.					
			Tons.	*Tons.*	*Ft.*	*Ft.*	*Ft.*		
425	15878	Lioness No. 2	404.67	404.67	175.0	33.0	5.5	Pittsburgh, Pa	Cincinnati, Ohio.
426	140484	Little Dick	126.65	126.65	123.0	23.7	4.0	do	Pittsburgh, Pa.
427	140218	Little Eagle No. 2	82.65	82.65	130.7	19.2	3.9	Jeffersonville, Ind	Kansas City, Mo.
428	140486	Little Fred	126.88	126.88	129.0	24.0	3.6	Pittsburgh, Pa	Pittsburgh, Pa.
429	140637	Little Ike	135.19	98.19	96.0	21.6	3.9	do	Do.
430	140422	Little Samson	118.84	118.84	119.8	20.6	3.2	Cincinnati, Ohio	Cincinnati, Ohio.
431	140264	Lizzie	52.18	52.18	71.0	16.5	3.5	Middleport, Ohio	Wheeling, W. Va.
432	140823	Lizzie Bay	176.39	176.39	150.0	30.0	4.4	Madison, Ind	Cincinnati, Ohio.
433	15549	Lizzie Bayliss	110.05	110.05	117.0	21.0	3.0	Wellesville, Ohio	Vicksburg, Miss.
434	140049	Lizzie Cassell	177.44	177.44	138.0	24.0	4.0	Marietta, Ohio	Wheeling, W. Va.
435	15827	Lizzie Gardner	70.54	70.54	124.5	21.0	3.6	Cincinnati, Ohio	La Crosse, Wis.
436	140568	Lizzie Townsend	177.64	88.82	129.6	26.0	3.5	Brownsville, Pa	Wheeling, W. Va.
437	15921	Longfellow	93.59	93.59	112.0	19.6	4.3	Jeffersonville, Ind	Evansville, Ind.
438	140938	Lorraine	138.49	104.09	135.0	30.2	4.8	Cincinnati, Ohio	Cincinnati, Ohio.
439	140192	Louis A. Sherley	407.55	407.55	221.0	34.7	5.2	Madison, Ind	Do.
440	140529	Louise	234.55	234.55	158.0	28.5	4.5	Cincinnati, Ohio	Do.
441	140917	Louisiana	56.39	30.51	98.2	18.1	4.6	Algiers, La	New Orleans, La.
442	140681	Lucy Robertson	103.84	81.89	95.0	20.5	2.9	Johnsonville, Tenn	Paducah, Ky.
443	140199	Lud Keefer	161.68	161.68	132.0	24.0	4.0	Pittsburgh, Pa	Pittsburgh, Pa.
444	140706	Luella	99.34	99.34	117.0	24.0	3.4	Prescott, Wis	La Crosse, Wis.
445	140523	Lulu Wood	123.32	123.32	123.0	24.4	4.1	Pittsburgh, Pa	Pittsburgh, Pa.
446	15804	Lumberman	73.37	73.37	127.5	27.7	4.4	Oshkosh, Wis	Burlington, Iowa.
447	140837	Lumberman	99.82	99.82	116.0	22.8	4.4	Evansville, Ind	Vicksburg, Miss.
448	91965	M. H. Clift	163.74	93.95	104.0	18.0	3.5	Chattanooga, Tenn	Chattanooga, Tenn
449	91511	M. P. Reed	111.25	65.29	65.0	25.0	3.4	do	Do.
450	90887	Mab	83.36	83.36	122.0	20.6	4.8	Grand Tower, Ill	St. Louis, Mo.
451	91604	Mabel Comceaux	160.06	160.06	145.2	29.8	5.8	New Richmond, Ohio	Do.
452	91133	Madison	53.21	53.21	84.0	24.0	5.0	Madison, Ind	Louisville, Ky.
453	91330	Maggie	193,14	134,09	131.0	24.0	4.0	Pittsburgh, Pa	Pittsburgh, Pa.
454	91858	Maggie Belle	52.81	52.81	95.6	18.4	3.6	Madison, Ind	Louisville, Ky.
455	91212	Maggie Paden	77.04	77.04	95.7	27.0	4.2	Ironton, Ohio	Wheeling, W. Va.
456	91014	Maggie Reaney	148.62	148.62	128.5	25.0	4.5	Hudson, Wis	St. Paul, Minn.
457	91739	Marian	522.09	522.09	206.0	46.0	6.7	Jeffersonville, Ind	Memphis, Tenn.
458	91331	Mark Wimrett	144.45	144.45	120.0	23.4	4.0	Pittsburgh, Pa	Cincinnati, Ohio.
459	91588	Martha	147.81	147.81	120.0	30.0	3.9	Murraysville, W. Va.	Memphis, Tenn.
460	91126	Mary Barnes	152.28	152.28	137.0	24.7	4.2	La Crosse, Wis	La Crosse, Wis.
461	90840	Mary Lewis	167.42	167.42	126.0	26.7	4.5	Jeffersonville, Ind	New Orleans, La.
462	91237	Mary Morton	456.96	450.64	210.0	32.5	6.0	Dubuque, Iowa	Dubuque, Iowa.
463	91921	Mary Ruble	65.73	65.73	100.0	16.7	3.0	Carrsville, Ky	Cincinnati, Ohio.
464	91207	Mary C. Campbell	64.73	64.73	100.0	28.0	3.0	Pittsburgh, Pa	Pittsburgh, Pa.
465	91385	Mary M. Michael	234.34	234.34	143.3	26.3	4.4	New Albany, Ind	St. Louis, Mo.
466	91904	Matt F. Allen	245.12	245.12	149.0	28.0	4.0	Jeffersonville, Ind	Nashville, Tenn.
467	90999	Mattie Hayes	56.89	56.89	100.0	20.0	3.4	do	Louisville, Ky.
468	91369	Mattie Lee	104.80	104.80	110.0	28.0	4.0	Grafton, Ill	Kansas City, Mo.
469	91783	Maude	191.26	101.05	106.0	20.6	4.5	Paducah, Ky	Memphis, Tenn.
470	90821	May Brian	97.40	97.40	115.0	28.0	4.5	Jeffersonville, Ind	St. Louis, Mo.
471	125523	May Fisher	52.84	52.84	92.0	18.8	4.0	Memphis, Tenn	New Orleans, La.
472	91929	May Flower	928.85	718.04	187.0	44.0	5.4	Pittsburgh, Pa	Pittsburgh, Pa.
473	91665	Metie	61.10	61.10	86.4	12.0	4.0	De Soto, Wis	Vicksburg, Miss.
474	91086	Mike Davis	112.28	78.92	96.0	17.0	3.0	Wheeling, W. Va.	Paducah, Ky.
475	91027	Mink No. 2	166.50	166.50	132.0	21.0	3.5	Harmar, Ohio	Cincinnati, Ohio.
476	91599	Minnetonka	381.63	381.63	175.0	30.0	5.2	Jeffersonville	Pittsburgh, Pa.
477	90730	Minnie	90.23	41.68	86.4	21.2	3.3	Shoals, Ind	New Orleans, La.
478	91321	Minnie No. 2	312.76	312.76	125.0	39.6	5.2	Cincinnati, Ohio	Cincinnati, Ohio.
479	91224	Minnie H	130.24	130.24	133.0	25.0	3.0	Reed's Landing, Minn.	St. Paul, Minn.
480	91538	Minnie Bay	196.21	196.21	182.0	27.0	4.8	Belle Vernon, Pa	Cincinnati, Ohio.
481	91164	Missouri	340.59	340.59	191.7	31.7	6.3	Metropolis, Ill	St. Louis, Mo.
482	17310	Mollie Mohler	135.32	135.32	121.0	21.0	4.0	Carver, Minn	La Crosse, Wis.
483	90152	Mollie Ragen	285.51	285.51	153.0	32.4	4.8	Evansville, Ind	Wheeling, W. Va.
484	91628	Monterey	107.93	74.18	92.0	18.8	3.4	Pittsburgh, Pa	Pittsburgh, Pa.
485	90111	Mount Clare	266.37	266.37	132.0	25.3	4.6	Wheeling, W. Va.	Cincinnati, Ohio.
486	90374	Mount'n Belle	193.76	193.76	140.0	27.0	4.4	Pittsburgh, Pa	La Crosse, Wis.
487	91347	Mountain Girl	108.55	108.55	115.3	24.4	3.2	Ashland, Ky	Louisville, Ky.
488	91230	Music	321.53	321.53	150.0	47.0	4.5	New Albany, Ind	Louisville, Ky.
489	91829	Musser	163.63	163.63	137.0	24.0	4.6	Dubuque, Iowa	Burlington, La.
490	90870	My Choice	462.23	462.23	183.0	35.0	5.0	Pittsburgh, Pa	St. Louis, Mo.
491	91796	Myra	148.42	99.02	100.0	18.0	3.5	Chattanooga, Tenn.	Chattanooga, Tenn.
492	130390	N. B. Garner	59.15	59.15	100.6	24.5	3.3	Pineville Rapids, La.	New Orleans, La.
493	18778	Nail City	191.33	191.33	134.0	24.0	4.0	Wheeling, W. Va.	Wheeling, W. Va.
494	130171	Napoleon Mulliken.	354.02	354.02	165.0	42.8	6.0	Jeffersonville, Ind.	St. Louis, Mo.

IV.—*List of merchant steam-boats navigating the Mississippi River, etc.*—Continued.

List No.	Official No.	Name.	Tonnage.		Length.	Breadth.	Depth.	Where built.	Home port.
			Gross.	Net.					
			Tons.	*Tons.*	*Ft.*	*Ft.*	*Ft.*		
495	130265	Nathaniel	52.93	52.93	85.0	20.3	3.9	Steubenville, Ohio	Wheeling, W. Va.
496	130400	Nellie P	54.15	27.08	67.0	12.0	3.5	New Iberia, La.	Brashear, La.
497	130359	Nellie Hudson	213.31	166.01	141.3	25.0	3.4	Pittsburgh, Pa.	Pittsburgh, Pa.
498	130017	Nellie Speer	224.10	224.10	145.4	27.0	5.0	... do	Do
499	130018	Nellie Walton	148.54	148.54	124.0	22.0	4.5	...do	Do
500	130204	Netta Duran. t	64.10	64.10	100.0	18.5	3.5	Baytown, Minn.	Galena, Ill.
501	130111	New Camelia	270.18	135.09	176.5	27.5	8.4	New Orleans, La.	New Orleans, La.
502	18708	New Ella	90.34	90.34	117.8	26.0	4.9	Leavenworth, Kans.	Omaha, Nebr.
503	130217	New Haven	92.64	92.64	136.1	24.4	3.4	Grafton, Ill.	St. Louis, Mo.
504	130327	New Jennie	77.19	41.26	104.0	28.2	4.0	Madisonville, La.	New Orleans, La.
505	130368	New Pike	75.21	75.21	115.0	25.0	3.5	Madison, Ind.	St. Louis, Mo.
506	130122	New Shallcross	248.77	248.77	160.0	36.9	6.1	Jeffersonville, Ind.	Louisville, Ky.
507	130222	Nick Sauer	99.27	99.27	100.0	18.2	4.0	Chester, Ill.	St. Louis, Mo.
508	130280	Nora Bell	68.33	58.39	114.0	20.6	3.6	Chambersburgh, Ohio.	Louisville, Ky.
509	130153	Northern Pacific	328.82	328.82	194.0	37.2	5.2	Mound City, Ill	Vicksburg, Miss.
510	130352	Novelty	63.14	49.95	76.4	16.4	3.0	Manchester, Ohio.	Do.
511	155126	O. R. Singleton	110.34	110.34	77.0	19.0	4.4	Edinburgh, Miss.	Do.
512	19425	Oakland	628.81	628.81	210.0	35.0	6.0	Pittsburgh, Pa.	St. Louis, Mo.
513	155142	Octavia	95.23	62.84	76.5	16.5	3.0	Greenville, Miss	Memphis, Tenn.
514	125716	Ohio	716.40	716.40	251.0	39.0	5.5	Cincinnati, Ohio	Cincinnati, Ohio.
515	19470	Old Hickory No. 2	97.18	97.18	109.0	28.6	4.7	West Point, Ky.	Louisville, Ky.
516	155056	Olivette	130.01	94.44	120.0	22.0	3.0	Harmar, Ohio	Cincinnati, Ohio.
517	155136	Ollie Neville	70.56	70.56	92.9	26.5	3.4	Brownsville, Pa.	Wheeling, W. Va.
518	155045	Oneida	75.78	75.78	104.0	19.7	4.0	Harmar, Ohio	Do.
519	155080	Oneida	140.46	140.46	111.3	35.2	5.5	Cincinnati, Ohio	Cincinnati, Ohio.
520	19483	Onward	314.89	314.89	165.0	30.5	5.5	Pittsburgh, Pa.	Pittsburgh, Pa.
521	150210	P. Dickinson	205.97	147.65	122.0	28.0	4.0	Kingston, Tenn	Chattanooga, Tenn
522	150152	Pacific	457.87	457.87	122.8	35.8	6.1	Metropolis, Ill	St. Louis, Mo.
523	150249	Pallie	155.58	88.43	109.0	38.5	4.8	Franklin, La.	Brashear, La.
524	150323	Park Bluff	96.89	96.89	107.3	22.7	3.5	Rock Island, Ill.	Burlington, Iowa.
525	20435	Park Painter No. 2	103.49	103.49	118.0	21.0	4.0	Pittsburgh, Pa.	Pittsburgh, Pa.
526	150168	Parole	113.84	113.84	128.9	20.6	4.0	Madison, Ind	Evansville, Ind.
527	150147	Pauline	101.98	101.98	112.0	21.0	3.5	Stillwater, Minn.	La Crosse, Wis.
528	150189	Pauline	83.90	83.90	112.6	23.7	3.2	Alexandria, La	Brashear, La.
529	150282	Pearl	149.95	149.95	228.2	23.5	4.1	Metropolis, Ill	St. Louis, Mo.
530	150403	Pearl	73.98	73.98	140.0	22.0	2.0	Jeffersonville, Ind	Paducah, Ky.
531	150144	Pearl River	106.76	106.76	118.0	26.0	5.0	Gainesville, Tex.	New Orleans, La.
532	150110	Penguin	60.68	60.68	80.0	16.6	3.4	Burlington, Iowa	Burlington, Iowa.
533	150244	Percy Kelsey	244.67	244.67	148.0	31.0	4.0	Pittsburgh, Pa	Pittsburgh, Pa.
534	91422	Percy Swain	115.53	115.53	129.8	19.7	3.5	Reed's Landing, Minn.	La Crosse, Wis.
535	20060	Pete Wilson	69.36	69.36	90.0	18.3	3.3	Menomonee, Wis	La Crosse, Wis.
536	145230	Phil. Armour	314.65	314.65	149.0	29.0	4.3	Jeffersonville, Ind.	Vicksburg, Miss.
537	150142	Phil. Sheckel	108.00	108.00	114.0	20.5	3.0	Waubeck, Wis.	La Crosse, Wis.
538	150302	Phœnix	310.33	191.69	140.0	40.6	5.1	Pittsburgh, Pa.	Pittsburgh, Pa.
539	20442	Piasa	164.45	164.45	131.4	24.0	3.8	Grafton, Ill	Evansville, Ind.
540	150242	Pilot	118.73	118.73	118.8	21.2	3.7	Le Claire, Iowa	Galena, Ill
541	150406	Pinhook	160.36	90.60	94.0	18.0	3.0	Chattanooga	Chattanooga, Tenn.
542	150172	Pittsburgh	722.17	709.87	250.0	39.2	5.8	Cincinnati, Ohio	Dubuque, Iowa.
543	150363	Polar Wave	150.34	150.34	146.0	25.7	5.0	Jeffersonville, Ind	Saint Louis, Mo.
544	150119	Port Eads	334.38	334.38	197.8	33.3	6.0	Madison, Ind	Do.
545	150198	Potowonok	73.98	73.98	109.5	22.4	3.2	Fort Madison, Iowa	La Crosse, Wis.
546	125962	Prince	107.88	107.88	120.0	21.0	2.8	Harmar, Ohio	Wheeling, W. Va.
547	150274	Princess	85.37	85.37	115.5	20.6	3.5	...do	Do.
548	150126	Putnam	55.91	55.91	65.0	18.0	3.0	Point Pleasant	Do.
549	110612	R. A. Speed	210.13	140.57	124.0	22.0	4.2	Pittsburgh, Pa.	Memphis, Tenn.
550	76215	R. B. Kendall	70.00	70.00	105.0	18.0	3.0	...do	Pittsburgh, Pa.
551	110716	R. C. Gunter	565.34	337.30	153.0	28.0	4.0	Chattanooga, T	Chattanooga, Tenn.
552	110703	R. E. Phillips	84.06	79.60	110.8	20.0	2.3	Freedom, Pa	Wheeling, W. Va.
553	110419	R. G. Wheeler	140.17	140.17	126.0	26.2	3.9	Stillwater, Minn	St. Paul, Minn.
554	110614	R. L. Cobb	365.33	204.56	145.1	28.5	3.0	Little Rock, Ark.	Memphis, Tenn.
555	110575	Racket	55.62	52.84	90.1	16.2	3.6	Manchester, Ohio	Cincinnati, Ohio.
556	110204	Rainbow	50.18	50.18	85.0	18.0	4.0	Pittsburgh, Pa.	Pittsburgh, Pa.
557	110401	Rainbow	894.98	894.98	264.0	39.5	6.0	Jeffersonville, Ind	Louisville, Ky.
558	110754	Ralph	63.28	44 24	76.0	18.0	4.0	Pittsburgh, Pa.	Pittsburgh, Pa.
559	110509	Raymond Horner	688.58	688.58	195.0	45.0	6.7	...do	Do.
560	110371	Reindeer	56.36	56.36	103.0	19.0	3.0	Terre Haute, Ind.	Louisville, Ky.
561	110765	Reindeer	219.16	130.66	125.0	23.0	3.3	Dubuque, Iowa	Galena, Ill.
562	110679	Reliance	70.31	70.31	126.0	21.5	4.2	Portsmouth, Ohio.	Cincinnati, Ohio.
563	110266	Reny Macready	269.71	269.71	141.0	28.0	4.8	Jeffersonville, Ind	Memphis, Tenn.
564	110506	Rescue	135.40	135.40	126.0	24.3	3.7	Pittsburgh, Pa.	Pittsburgh, Pa.
565	110630	Rescue	139.03	139.03	121.0	26.8	3.4	St. Louis, Mo.	Burlington, Iow.
566	110510	Resolute	207.78	207.78	139.6	29.0	3.8	Pittsburgh, Pa.	Pittsburgh, Pa.

IV.—*List of merchant steam-boats navigating the Mississippi River, etc.*—Continued.

List No.	Official No.	Name.	Tonnage.		Length.	Breadth.	Depth.	Where built.	Home port.
			Gross.	Net.					
			Tons.	*Tons.*	*Feet*	*Ft.*	*Ft.*		
567	110487	Return	109.26	109.26	114.7	20.7	3.5	Baker's Landing, Pa.	Pittsburg, Pa.
568	110543	Robert Dodds	128.61	128.61	128.5	25.0	5.7	Stillwater, Minn	St. Louis, Mo.
569	110608	Robert Jenkins	234.67	174.82	129.0	22.6	4.4	Pittsburgh, Pa	Pittsburgh, Pa.
570	110090	Robert Peebles	242.22	242.22	147.5	28.2	4.0	Cincinnati, Ohio	Cincinnati, Ohio.
571	110255	Robert Young	203.03	203.03	136.5	25.1	4.7	Grand View, Ind.	New Orleans, La.
572	150176	Robert T. Oxley	56.19	50.43	108.6	17.3	3.6	Portsmouth, Ohio	Cincinnati, Ohio.
573	115629	Rob Roy	100.02	84.63	119.0	19.0	2.9	La Fayette, Ind	Kansas City, Mo.
574	110564	Rockwood	226.26	150.52	130.0	25.6	4.0	Kingston, Tenn	Chattanooga, Tenn.
575	110640	Rosedale	174.06	174.06	140.0	30.0	3.4	Ashland, Ky	Evansville, Ind.
576	110392	Roy	116.75	74.99	69.7	25.0	3.2	Bridgeport, Ind	Memphis, Tenn.
577	110075	Roy Lynds	64.19	64.19	101.0	23.0	3.0	Jeffersonville, Ind	St. Joseph, Mo.
578	80774	Rozelle	62.46	50.35	110.0	19.0	3.0	Charleston, W. Va.	Wheeling, W. Va.
579	110470	Ruby	54.22	54.22	105.0	23.0	4.2	De Soto, Wis	St. Paul, Minn.
580	110147	Russell Hinckley	327.79	327.79	169.8	42.6	5.6	Madison, Ind	St. Louis, Mo.
581	116030	S. P. Pond	86.34	56.27	75.0	15.5	3.0	Lockhart's Landing, Ark.	Memphis, Tenn.
582	115108	St. Croix	98.78	98.78	115.0	20.0	4.0	Maiden Rock, Wis	Galena, Ill.
583	115656	St. Lawrence	913.61	913.61	266.5	41.0	6.0	Wheeling, W. Va.	Cincinnati, Ohio.
584	23785	St. Louis	312.04	312.04	198 6	32.8	5.0	Freedom, Pa	Paducah, Ky.
585	115933	St. Paul	833.53	804.23	300.0	36.3	6.2	St. Louis, Mo	St. Louis, Mo.
586	116134	Sallie	68.25	68.25	109.0	23.9	3.3	Parkersburgh, W. Va.	Cincinnati, Ohio.
587	115787	Sam. Atlee	234.16	234.16	133.3	26.3	4.0	Rock Island, Ill	Burlington, Iowa.
588	115320	Sam. Roberts	80.06	80.06	90.0	25.0	4.5	Pittsburgh, Pa	Pittsburgh, Pa.
589	140458	Sam P. Jones	359.90	359.90	149.0	30.0	4.0	Jeffersonville, Ind	Paducah, Ky.
590	115503	Sammy	52.68	27.84	71.7	15.4	3.6	Berwick City, La	Brashear, La.
591	116155	Samson	58.34	29.42	52.8	21.3	3.3	Berwick, La	Do.
592	115125	Samuel Clark	435.82	435.82	175.0	33.0	6.0	Pittsburgh, Pa	Pittsburgh, Pa
593	115319	Samuel Miller	242.20	242.20	148.0	26.0	5.0	do	Do.
594	116065	Sam. P. Wiggins	364.87	364.87	177.6	47.4	6.6	Jeffersonville, Ind	St. Louis, Mo.
595	115738	Scotia	601.21	601.21	236.0	36.0	5.2	Pittsburgh, Pa	Pittsburgh, Pa.
596	115406	Scout	55.68	55.68	85.0	15.0	2.8	Freedom, Pa	Do.
597	116207	Sea Wing	109.55	109.55	110.0	20.8	4.5	Diamond Bluff, Wis	St. Paul, Minn.
598	115960	Sentinel	50.92	35.96	83.6	17.6	3.3	Pittsburgh, Pa	Pittsburgh, Pa.
599	115484	Seven Sons	95.81	95.81	112.0	22.0	4.0	do	Do.
600	115708	Short Cut	81.77	81.77	97.0	25.0	4.5	do	Do.
601	115715	Sidney	617.88	378.63	221.3	35.5	3.5	Wheeling, W. Va.	Dubuque, Iowa.
602	76189	Sidney Dillon	420.58	420.58	175.0	33.8	5.5	Pittsburgh, Pa	St. Louis, Mo.
603	23247	Silas Wright	91.51	91.51	106.0	20.2	3.8	Eau Claire, Wis	La Crosse, Wis.
604	115733	Silas P. Coe	301.56	301.56	159.6	28.5	4.6	Cincinnati, Ohio	Cincinnati, Ohio.
605	116011	Slackwater	181.07	140.42	116.6	25.0	3.3	Pittsburgh, Pa	Pittsburgh, Pa.
606	115128	Smoky City	549,36	549.36	194.0	35.0	6.0	do	Do.
607	115796	Sonoma	116.89	116.89	115.0	20.0	3.0	Harmar, Ohio	Wheeling, W. Va.
608	115757	Spread Eagle	529.34	529.34	224.5	33.8	5.7	Cincinnati, Ohio	St. Louis, Mo.
609	115980	Spring Hill	156.33	156.33	136.0	26.6	4.0	Charleston, W. Va	Wheeling, W. Va.
610	116119	Star	78.44	58.28	92.2	20.0	3.8	Pittsburgh, Pa	Pittsburgh, Pa.
611	115433	Stalie Fisher	106.52	106.52	122.0	28.0	4.0	Jeffersonville, Ind	St. Louis, Mo.
612	116121	Stella Wilds	289.12	289.12	156.6	30.5	4.6	Brownsville, Pa	Natches, Miss.
613	115589	Sterling White	117.09	117.09	120.0	30.5	4.2	New Albany, Ind.	New Orleans, La.
614	115161	Stillwater	146.45	146.45	125.1	24.4	3.8	Le Claire, Iowa	Burlington, Iowa.
615	115883	Stone Brothers	54.45	54.45	87.0	26.0	3.5	Point Pleasant, W Va.	Wheeling, W. Va.
616	115126	Storm	195.53	195,53	143.0	24.0	4.0	Pittsburgh, Pa	Cincinnati, Ohio.
617	116210	Sunshine	335,94	335.94	175.0	37.0	5.8	Jeffersonville, Ind.	Louisville, Ky.
618	115892	Susie Brown	73.49	73.49	95.0	30.5	4.9	Murraysville, W. Va.	Cincinnati, Ohio.
619	145290	T. Shiver	127.29	127.29	125.0	25.0	4.8	Spottsville, Ky	Paducah, Ky.
620	145378	T. D. Dale	85.77	70.89	111.6	19.7	3.2	Harmar, Ohio	Louisville, Ky.
621	24873	T. F. Eckert	510.43	510.43	176.0	34.5	5.0	Cincinnati, Ohio	St. Louis, Mo,
622	145410	T. P. Leathers	458.60	458.60	209.2	38.0	7.2	Freedom, Pa	Cincinnati, Ohio.
623	145348	Tacoma	266.92	266.92	180.2	30.0	5.1	New Richmond, Ohio.	Do.
624	145283	TanBark	379.10	379.10	176.7	38.5	6.6	Cincinnati, Ohio.	Do.
625	145438	Teche	485.90	485.90	190.0	38.0	5.5	Jeffersonville, Ind	New Orleans, La.
626	145117	Telegram	276.43	276.43	174.2	25.0	4.4	Brownville, Pa	Wheeling, W. Va.
627	145143	Telegraph	854.47	854.47	288.0	41.6	5.0	Cincinnati, Ohio	Cincinnati, Ohio.
628	145306	Ten Broeck	148.61	148.61	130.7	26.0	3.9	Baytown, Minn	Galena, Ill.
629	145396	T. A. Hendricks	81.86	81.86	108.0	22.5	4.2	Madison, Ind	Louisville, Ky.
630	24903	Thos. W. Means	266.26	266.26	146.2	27.8	5.1	Cincinnati, Ohio	Cincinnati, Ohio.

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			Gross.	Net.					
			Tons.	*Tons.*	*Feet.*	*Ft.*	*Ft.*		
631	145279	Tide	116.22	116.22	117.0	22.0	3.6	Clarington, Ohio	Pittsburgh, Pa.
632	145123	Tiger	186.20	186.20	150.7	21.8	4.0	Sioux City, Iowa	Memphis, Tenn.
633	91327	Tille	113.00	83.60	107.6	18.4	3 9	Harmar, Ohio	Pittsburgh, Pa.
634	157060	Time	382.36	382.36	164.8	37.0	5.3	Pittsburgh, Pa	Do.
635	24934	Tom Dodsworth	500.35	500.35	182.0	35.0	6.0	do	Do.
636	24936	Tom Lysle	121.68	121.68	118.0	21.0	4.5	do	Do.
637	24933	Tom Rees No 2	327.02	327.02	168.0	29.0	5.4	do	Do.
638	145339	Tom Spurlock	93.05	86.30	114.3	22.9	3.0	Ashland, Ky	Cincinnati, Ohio.
639	145235	Transfer	65.63	65.63	90.0	26.5	3.6	Ironton, Ohio	Do.
640	145031	Transit	119.08	119.08	118.0	23.0	4.0	Pittsburgh, Pa	Louisville, Ky.
641	145300	Twilight	119.12	119.12	113.0	23.0	3.8	do	Pittsburgh, Pa.
642	145369	Two Brothers	69.13	48.13	91.9	16.0	2.5	do	Do.
643	25206	Undine	72.90	72.90	112.0	30.0	2.0	Mound, City, Ill	Kansas City, Mo.
644	25932	V. Owen	114.66	114.66	125.5	35.0	4.0	Paducah, Ky	Paducah, Ky,
645	161513	Valley Belle	127.48	127.48	127.0	22.4	3.4	Harmer, Ohio	Wheeling, W. Va.
646	25937	Van Gooder	63.76	63.76	96.0	26.0	4.0	Winona, Minn	La Crosse, Wis.
647	75364	Venice	221.45	221.45	149.6	38.6	6.5	Jeffersonville, Ind.	St. Louis, Mo.
648	25726	Venture	144.06	144.06	117.0	20.0	3.5	Pittsburgh, Pa	Pittsburgh, Pa.
649	161555	Verne Swain	134.76	134.76	122.0	22.6	5.0	Stillwater, Minn	St. Paul, Minn.
650	25915	Vice President	197.37	197.37	164.0	34.0	5.0	Madison, Ind	Omaha, Nebr.
651	125785	Vienna	73.17	73.17	89.6	24.0	2.3	Plattsmouth, Nebr	St. Loius, Mo.
652	25831	Vigo	87.47	87.47	100.7	18.7	3.8	Terre Haute, Ind	Wheeling, W. Va.
653	161569	Virgie Ratliffe	92.55	42.15	113.0	16.0	4.3	Catlettsburgh, Ky.	Cincinnati, Ohio.
654	161543	Voyager	213.35	146.47	134.4	23.8	4.1	Pittsburgh, Pa	Pittsburgh, Pa.
655	80694	W. A. Johnson	199.58	199.58	150.0	29.0	4.0	Cincinnati, Ohio	Evansville, Ind.
656	80930	W. B. Cole	57.62	54.74	92.6	18.1	3.4	do	Cincinnati, Ohio.
657	81110	W. B. Trow	71.58	71.58	113.5	24.5	4.0	Winneconne, Wis.	La Crosse, Wis.
658	80936	W. C. Hite	345.21	345.21	155.0	36.0	6.3	Jeffersonville, Ind.	Louisville, Ky.
659	81000	W. F. Nisbet	576.86	576.86	200.0	35.0	6.1	do	Evansville, Ind.
660	80933	W. H. Cherry	396.07	396.07	169.0	32.0	5.2	do	St. Louis, Mo.
661	80468	W. J. Behan	288.62	288.62	165.0	33.0	4.0	do	Omaha, Nebr.
662	80808	W. L. Dugger	224.13	153.90	130.0	27.0	3.8	Chattanooga, Tenn	Chattanooga, Ten.
663	81186	W. L. Norton	63.01	43.60	67.5	12.0	3.0	Lenoir's, Tenn	Do.
664	80835	W. N. Chancellor	300.54	300.54	175.0	30.0	3.8	Wood County Va.	Wheeling, W. Va.
665	81035	W. P. Bishop	69.09	48.09	93.9	16.5	2.5	Pittsburgh, Pa	Omaha, Nebr.
666	80595	War Eagle	953.74	953.74	279.2	42.0	6.1	St. Louis, Mo	St. Louis, Mo.
667	80431	Warsaw	118.30	118.30	123.5	36.0	5.0	Madison, Ind	La Crosse, Wis.
668	80781	Water Lilly	141.17	89.96	112.0	21.0	3.0	Knoxville, Tenn	Chattanooga, Tenn.
669	80689	Whisper	362.23	362.23	180 9	36.2	6.8	Jeffersonville, Ind.	New Orleans, La.
670	105735	White Eagle	312.75	312.75	238.0	29.0	3.8	La Crosse, Wis	St. Louis, Mo.
671	18753	Wm. Bonner	172.11	172.11	132.0	24.0	4.5	Pittsburgh, Pa	Pittsburgh, Pa.
672	80669	William Ernst	197.64	197.64	140.0	25.2	4.0	Covington, Ky	Cincinnati, Ohio.
673	80790	Wm. Kraft	105.59	105.59	119.0	23.0	4.0	Pittsburgh, Pa	Pittsburgh Pa.
674	26398	William Osborne	162.04	162.04	126.0	32.0	4.8	do	Dubuque, Iowa.
675	81127	William Porter	168.14	168.14	150.0	25.0	5.0	Jeffersonville, Ind	Paducah, Ky.
676	80612	William Thaw	230.00	230.00	138.0	55.0	5.3	Pittsburgh, Pa	Pittsburgh, Pa.
677	81030	William Towns	98.08	98.08	120.5	26.0	3.4	Osceola, Mo	St. Louis, Mo.
678	80325	William Wagner	52.25	52.25	100.0	17.0	2.0	Pittsburgh, Pa	Wheeling, W. Va.
679	8875	Wm. G. Horner	122 44	122.44	125.0	22.5	4.0	do	Pittsburgh, Pa.
680	80888	Wm. J. Young, jr.	191.55	191.55	130.0	30.0	4.0	Dubuque, Iowa	Galena, Ill.
681	80842	Willie Cade	177.47	177.47	131.0	31.0	4.8	Metropolis, Ill	Kansas City, Mo.
682	81182	Wyeth City	255.96	138.96	120.0	21.5	4.8	Chattanooga, Tenn	Chattanooga, Tenn.
683	80741	Wyoming	1,034.15	1,034.15	257.0	45.0	6.0	Pittsburgh, Pa	St. Louis, Mo.
684	27608	Yellowstone	167.27	167.27	150.0	30.4	5.0	Jeffersonville, Ind.	St. Paul, Minn.
685	28083	Z. M. Shively	193.58	193.58	154.5	34.5	4.8	do	Louisville, Ky.
686	125086	Clyde	121.20	121.20	125.0	19.0	4.0	Dubuque, Iowa	Dubuque, Iowa.
687	76589	J. K. Graves	96.72	96.72	117.0	20.0	4.0	do	St. Paul, Minn.

Six hundred and eighty-seven boats; 138,562.25 total tonnage; 94 3 per cent. of all boats and 76.5 per cent. of tonnage navigating Mississippi River.


DES PLAINES
EVANSTON
Chicago Div.
BOWMAN YKLE
CUT OFF
Norwood Park
Jefferson
Irving Park
Salt Creek
Des Plaines River
MAYWOOD
Oak Park
Wheaton
RIVERSIDE
Western Springs
MUD LAKE
Hinsdale
La Grange
Summit
Downer's Grove
DES PLAINES RIV
LAKE
CHICAGO
LAKE MICHIGAN
Willow Springs
Sag Bridge
Lemont
Pullman
Kensington
STAGG'S ISLAND
Romeo
BLUE ISLAND
Grand Calumet River
Hammond
Little Calumet River
LOCKPORT
Head of Lake Joliet
JOLIET
CHICAGO DIVIDE
LAKE MICHIGAN TO LAKE JOLIET.
Sag Bridge
Willow Springs
Summit
Mud Lake
Western Avenue
Low Water Line of Lake Michigan
Miles 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
DES PLAINES AND MUD LAKE.
Sag Junction
Blue Island
Calumet River
Miles 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3
Feet
SAG AND CALUMET ROUTE.
JOLIET
Lockport
LEMONT
Head of Lake Joliet
Adams Dam
Dam No. 1
Lock
SAG JUNCTION
Miles
SAG BRIDGE TO LAKE JOLIET.

H Ex. 2164 511

CHICAGO DRAINAGE AND WATER-WAY LAWS.

[From the Chicago Legal News Edition of the Laws of 1889.]

TO CREATE SANITARY DISTRICTS AND TO REMOVE OBSTRUCTIONS IN THE DESPLAINES AND ILLINOIS RIVERS, ETC.

Section.
186. Incorporating sanitary district—question, how submitted—commissioners, etc.
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189. Trustees constitute a board—duties and powers of.
190. Ordinance making appropriation—publication of.
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192. Board of trustees—powers of.
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194. May borrow money—limitation.
195. To provide for direct annual tax—net earnings.
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201. Private property—how taken for improvement.
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204. Liability of sanitary district for damages.
205. Capacity of channel or outlet.
206. Sanitary district—failure to comply with act—remedy—penalty.
207. Act—how construed.
208. Channel—how to be constructed.
209. Channel—when completed—control of.
210. May permit territories outside to drain, etc.
211. When city or village owns water-works, etc.
212. When channel constructed—commissioners to inspect its work.

AN ACT to create sanitary districts and to remove obstructions in the Desplaines and Illinois rivers. Approved May 29, 1889. In force July 1, 1889.

186. INCORPORATING SANITARY DISTRICT—QUESTION, HOW SUBMITTED—COMMISSIONERS.] § 1. *Be it enacted by the people of the State of Illinois, represented in the general assembly*, That whenever any area of contiguous territory within the limits of a single county shall contain two or more incorporated cities, towns, or villages, and shall be so situated that the maintenance of a common outlet for the drainage thereof will conduce to the preservation of the public health, the same may be incorporated as a sanitary district under this act, in the manner following: Any 5,000 legal voters resident within the limits of such proposed sanitary district may petition the county judge of the county in which they reside to cause the question to be submitted to the legal voters of such proposed district whether they will organize as a sanitary district under this act. Such petition shall be addressed to the county judge, and shall contain a definite description of the territory intended to be embraced in such district, and the name of such proposed sanitary district: *Provided, however*, That no territory shall be included in any municipal corporation formed hereunder which is not situated within the limits of a city, incorporated town, or village, or within three miles thereof, and no territory shall be included within more than one sanitary district under this act. Upon the filing of such petition in the office of the county clerk of the county in which such territory is situated it shall be the duty of the county judge to call to his assistance two judges of the circuit court and such judges shall constitute a board of commissioners which shall have power and authority to consider the boundaries of any such proposed sanitary district, whether the same shall be described in such petition or otherwise. Notice shall be given by such county judge of the time and place where such commissioners will meet, by a publication inserted in one or more daily papers published in such county, at least twenty days prior to such meeting. At such meeting the county judge shall preside, and all persons in such proposed sanitary district shall have an opportunity to be heard touching the location and boundary of such proposed district and make suggestions regarding the same, and such commissioners, after hearing statements, evidence, and suggestions, shall fix and determine the limits and boundaries of such proposed district, and for that purpose and to that extent, may alter and amend such petition. After such determination by said commissioners, or a majority of them, the county judge shall submit to the legal voters of the proposed sanitary district the question of the organization and establishment of the proposed sanitary district, as determined by said commissioners, at an election to be held on the first Tuesday after the first Monday in November thence next ensuing. Notice whereof shall be given by said commissioners, at least twenty days prior thereto, by publication in one or more daily papers published within such proposed sanitary district, such notice to specify briefly the purpose of such election, with a description of such proposed district. Each legal voter resident within such proposed sanitary district shall have the right to cast a ballot at such election, with the words thereon, "For Sanitary District," or "Against Sanitary District." The ballots so cast shall be received, re-

turned, and canvassed in the same manner and by the same officers as is provided by law in the case of ballots cast for county officers. The county judge shall cause a statement of the result of such election to be spread upon the records of the county court. If a majority of the votes cast upon the question of the incorporation of the proposed sanitary district shall be in favor of the proposed sanitary district, such proposed district shall thenceforth be deemed an organized sanitary district under this act.

187. JUDICIAL NOTICE OF DISTRICT—ORGANIZATION—ELECTION—COUNTY JUDGE.] § 2. All courts in this State shall take judicial notice of the existence of all sanitary districts organized under this act. Upon the organization of any sanitary district under this act the county judge shall call an election to elect officers and cause notice thereof to be posted or published, and perform all other acts in reference to such election in like manner as nearly as may be, as he is required to perform in reference to the election of officers in newly organized cities under the provisions of an act entitled "An act to provide for the incorporation of cities and villages," approved April 10, 1872.

188. TRUSTEES—ELECTION AND TERMS OF.] § 3. In each sanitary district organized under this act there shall be elected nine trustees who shall hold their offices for five years, and until their successors are elected and qualified, except the term of office of the first trustees elected shall be until five years after the first Monday in December after their election. The election of trustees, after the first, shall be on the Tuesday next after the first Monday in November in every fifth year. In all elections for trustees each qualified voter may vote for as many candidates as there are trustees to be elected, or he may distribute his vote among not less than five-ninths of the candidates to be elected, giving to each of the candidates among whom he distributes the same, the same number of votes or fractional parts of votes. The trustees shall choose one of their number president, and such sanitary district shall from the time of the first election held by it under this act be construed in law and equity a body corporate and politic and by the name and style of the sanitary district of ———, and by such name and style may sue and be sued, contract and be contracted with, acquire and hold real estate and personal property necessary for corporate purposes, and adopt a common seal and alter the same at pleasure.

189. TRUSTEES CONSTITUTE A BOARD—DUTIES AND POWERS OF.] § 4. The trustees elected in pursuance of the foregoing provisions of this act shall constitute a board of trustees for the district by which they are elected, which board of trustees is hereby declared to be the corporate authorities of such sanitary district, and shall exercise all the powers and manage and control all the affairs and property of such district. Said board of trustees shall have the right to elect a clerk, treasurer, chief engineer, and attorney for such municipality, who shall hold their respective offices during the pleasure of the board, and who shall give such bond as may be required by said board. Said board may prescribe the duties and fix the compensation of all the officers and employés of said sanitary district: *Provided, however,* That the salary of the president of said board of trustees shall in no case exceed the sum of four thousand dollars per annum; and the salary of the other members of said board shall not exceed three thousand dollars per annum. *And provided further,* That the amount received by any attorney shall not exceed the sum of five thousand dollars ($5,000) per annum. Said board of trustees shall have full power to pass all necessary ordinances, rules, and regulations for the proper management and conduct of the business of said board of trustees and of said corporation, and for carrying into effect the objects for which such sanitary district is formed.

190. ORDINANCES MAKING APPROPRIATION—PUBLICATION OF.] § 5. All ordinances making any appropriations shall, within one month after they are passed, be published at least once in a newspaper published in such district, or if no such newspaper of general circulation is published therein, by posting copies of the same in three public places in the district; and no such ordinance shall take effect until ten days after it is so published, and all other ordinances, orders, and resolutions shall take effect from and after their passage unless otherwise provided therein.

191. ORDINANCES AND RESOLUTIONS—EVIDENCE.] § 6. All ordinances, orders, and resolutions, and the date of publication thereof, may be proven by the certificate of the clerk, under the seal of the corporation, and when printed in book or pamphlet form, and purporting to be published by the board of trustees, and such book or pamphlet shall be received as evidence of the passage and legal publication of such ordinances, orders, and resolution, as of the dates mentioned in such book or pamphlet, in all courts and places without further proof.

192. BOARD OF TRUSTEES—POWERS OF.] § 7. The board of trustees of any sanitary district organized under this act shall have power to provide for the drainage of such district by laying out, establishing, constructing, and maintaining one or more main channels, drains, ditches, and outlets for carrying off and disposing of the drainage (including the sewage) of such district, together with such adjuncts and additions thereto as may be necessary or proper to cause such channels or outlets to

accomplish the end for which they are designed in a satisfactory manner; also to make and establish docks adjacent to any navigable channel made under the provisions hereof for drainage purposes, and to lease, manage, and control such docks, and also to control and dispose of any water-power which may be incidentally created in the construction and use of said channels or outlets, but in no case shall said board have any power to control water after it passes beyond its channels, waterways, races, or structures into a river or natural water-way or channel or water-power or docks situated on such river or natural water-way or channel: *Provided, however*, Nothing in this act shall be construed to abridge or prevent the State from hereafter requiring a portion of the funds derived from such water-power, dockage, or wharfage to be paid into the State treasury to be used for State purposes. Such channels or outlets may extend outside of the territory included within such sanitary district, and the rights and powers of said board of trustees over the portion of such channel or outlet lying outside of such district shall be the same as those vested in said board over that portion of such channels or outlets within the said district.

193. MAY PURCHASE AND SELL REAL ESTATE, ETC.] § 8. Such sanitary district may acquire by purchase, condemnation, or otherwise any and all real and personal property, right of way, and privilege, either within or without its corporate limits that may be required for its corporate purposes: *Provided*, All moneys for the purchase and condemnation of any property shall be paid before possession is taken, or any work done on the premises damaged by the construction of such channel or outlet, and in case of an appeal from the county court taken by either party whereby the amount of damages is not fully determined, the amount of judgment in such court shall be deposited at some bank to be designated by the judge thereof subject to the payment of such damages on orders signed by such county judge, whenever the amount of damages is finally determined; and when not longer required for such purposes, to sell, convey, vacate, and release the same, subject to the reservation contained in section 7 relating to water-powers and docks.

194. MAY BORROW MONEY—LIMITATION.] § 9. The corporation may borrow money for corporate purposes and may issue bonds therefor, but shall not become indebted, in any manner or for any purpose, to an amount in the aggregate to exceed five per centum on the valuation of taxable property therein, to be ascertained by the last assessment for State and county taxes previous to the incurring of such indebtedness: *Provided, however*, That said five per centum shall not exceed the sum of fifteen million dollars ($15,000,000).

195. TO PROVIDE FOR DIRECT ANNUAL TAX—NET EARNINGS.] § 10. At the time or before incurring any indebtedness the board of trustees shall provide for the collection of a direct annual tax sufficient to pay the interest on such debt as it falls due, and also to pay and discharge the principal thereof as the same shall fall due, and at least within twenty years from the time of contracting the same: *Provided*, That the net earnings from water-power and docks may be appropriated and applied to the purpose of paying the interest or principal of such indebtedness, or both, and to the extent that they will suffice, the direct tax may be remitted.

196. CONTRACTS—HOW LET.] § 11. All contracts for work to be done by such municipality, the expense of which will exceed five hundred dollars, shall be let to the lowest responsible bidder therefor upon not less than sixty days' public notice of the terms and conditions upon which the contract is to be let having been given by publication in a newspaper of general circulation published in said district, and the said board shall have the power and authority to reject any and all bids, and re-advertise: *Provided*, No person shall be employed on said work unless he be a citizen of the United States, or has in good faith declared his intentions to become such citizen. In all cases where an alien, after filing his declaration of intention to become a citizen of the United States, shall, for the space of three months after he could lawfully do so, fail to take out his final papers and complete his citizenship, such failure shall be *prima facie* evidence that his declaration of intentions was not made in good faith. And that eight hours shall constitute a day's work.

197. TRUSTEES MAY LEVY AND COLLECT TAXES, ETC.] § 12. The board of trustees may levy and collect taxes for corporate purposes upon property within the territorial limits of such sanitary district, the aggregate amount of which in any one year shall not exceed one-half of one per centum of the value of the taxable property within the corporate limits, as the same shall be assessed and equalized for State and county taxes of the year in which the levy is made. Said board shall cause the amount required to be raised by taxation in each year to be certified by the county clerk, on or before the second Tuesday in August, as provided in section one hundred and twenty-two of the general revenue law. All taxes so levied and certified shall be collected and enforced in the same manner and by the same officers as State and county taxes, and shall be paid over by the officer collecting the same to the treasurer of the sanitary district in the manner and at the time provided by the general revenue law.

198. [EXPENSES OF IMPROVEMENT—SPECIAL ASSESSMENTS—GENERAL TAX.] § 13. The board of trustees shall have power to defray the expenses of any improvement made by it in the execution of the powers hereby granted to such incorporation by special assessment or by general taxation, or partly by special assessment and partly by general taxation, as they shall by ordinance prescribe. It shall constitute no objection to any special assessment that the improvement for which the same is levied is partly outside the limits of such incorporation, but no special assessment shall be made upon property situated outside of such sanitary district, and in no case shall any property be assessed more than it will be benefited by the improvement for which the assessment is levied. The proceedings for making, levying, collecting, and enforcing of any special assessment levied hereunder shall be the same as nearly as may be as is prescribed by article nine of an act entitled "An act to provide for the incorporation of cities and villages," approved April 10, 1872. Whenever in said act the words "city council" are used the same shall apply to the board of trustees constituted by this act, and the words applying to the city or its officers in that article shall be held to apply to the corporation hereby created and to its officers.

199. [ASSESSMENT—INSTALLMENTS—INTEREST.] § 14. When any assessment is made under this act the ordinance authorizing such assessment may provide that it be divided into equal annual installments, not more than twenty in number, and fix the amount and time of payment of each installment, and that the installment shall bear interest at a rate not exceeding six per cent. per annum, payable annually, from the date fixed in said ordinance, and the several installments and interests thereon may be collected and enforced, as they shall become due, in the manner provided for the enforcement of assessments under said article 9. No more of any assessment need be returned or certified to the county collector than will show the amount due and unpaid at the time of such return, and no sale of any parcel of land for any installment of an assessment shall discharge the premises from any subsequent installment of the same or any other assessment. Any one or all of the installments may be paid any time after the assessment is confirmed, with accrued interest, if any, to the date of payment.

200. WHEN ASSESSMENTS PAYABLE BY INSTALLMENTS—BONDS MAY BE ISSUED.] § 15. Where any assessment is made payable in installments the board of trustees may issue bonds or certificates not exceeding in amount eighty per centum of the unpaid portion of such assessment at the date of the issue thereof, payable only out of such assessment, and bearing interest at a rate not exceeding the rate of interest upon the installments of such assessments. The board of trustees shall have the right to call in and pay off said bonds or certificates as fast as there is money received into the treasury from the assessment against which the same are issued, and all moneys received upon such assessments shall be applied to the payment of said certificates or bonds until they are fully satisfied.

201. PRIVATE PROPERTY—HOW TAKEN FOR IMPROVEMENT.] § 16. Whenever the board of trustees of any sanitary district shall pass an ordinance for the making of any improvement which such district is authorized to make, the making of which will require that private property should be taken or damaged, such district may cause compensation therefor to be ascertained, and condemn and acquire possession thereof in the same manner as nearly as may be as is provided in an act entitled, "An act to provide for the exercise of the right of eminent domain," approved April 10, 1872: *Provided, however,* That proceedings to ascertain the compensation to be paid for taking or damaging private property shall in all cases be instituted in the county where the property sought to be taken or damaged is situated: *And provided,* That all damages to property, whether determined by agreement or by final judgment of court, shall be paid out of the annual district tax prior to the payment of any other debt or obligation.

202. MAY ACQUIRE RIGHT OF WAY.] § 17. When it shall be necessary, in making any improvements which any district is authorized by this act to make, to enter upon any public property or property held for public use, such district shall have the power so to do and may acquire the necessary right of way over such property held for public use in the same manner as is above provided for acquiring private property, and may enter upon, use, widen, deepen, and improve any navigable or other waters, water-ways, canal, or lake: *Provided,* The public use thereof shall not be unnecessarily interrupted or interfered with, and that the same shall be restored to its former usefulness as soon as practicable: *Provided, however,* That no such district shall occupy any portion of the Illinois and Michigan Canal outside of the limits of the county in which such district is situated for the site of any such improvement, except to cross the same, and then only in such a way as not to impair the usefulness of said canal or to the injury of the right of the State therein, and only under the direction and supervision of the canal commissioners: *And provided further,* That no district shall be required to make any compensation for the use of so much of said canal as lies within the limits of the county in which said district is situated except for transportation purposes.

203. SPECIAL ASSESSMENT—DAMAGE TO PROPERTY AND COST OF ACQUIRING.] § 18. In making any special assessment for any improvement which requires the taking or damaging of property, the cost of acquiring the right to damage or take such property may be estimated and included in the assessment as a part of the cost of making such improvement.

204. LIABILITY OF SANITARY DISTRICT FOR DAMAGES.] § 19. Every sanitary district shall be liable for all damages to real estate within or without such district which shall be overflowed or otherwise damaged by reason of the construction, enlargement, or use of any channel, ditch, drain, outlet, or other improvement under the provisions of this act; and actions to recover such damages may be brought in the county where such real estate is situate, or in the county where such sanitary district is located, at the option of the party claiming to be injured. And in case judgment is rendered against such district for damage, the plaintiff shall also recover his reasonable attorney's fees, to be taxed as costs of suit: *Provided, however*, It shall appear on the trial that the plaintiff notified the trustees of such district, in writing, at least 60 days before suit was commenced by leaving a copy of such notice with some one of the trustees of such distrct stating that he claims damages to the amount of..... dollars by reason of (here insert the cause of damage), and intends to sue for the same: *And provided further*, That the amount recovered shall be larger than the amount offered by said trustees (if anything) as a compromise for damages sustained.

205. CAPACITY OF CHANNEL OR OUTLET.] § 20. Any channel or outlet constructed under the provisions of this act, which shall cause the discharge of sewage into or through any river or stream of water beyond or without the limits of the district constructing the same, shall be of sufficient size and capacity to produce a continuous flow of water of at least two hundred cubic feet per minute for each one thousand of the population of the district drained thereby, and the same shall be kept and maintained of such size and in such condition that the water thereof shall be neither offensive or injurious to the health of any of the people of this State; and before any sewage shall be discharged into such channel or outlet, all garbage, dead animals, and parts thereof, and other solids shall be taken therefrom.

206. SANITARY DISTRICT—FAILURE TO COMPLY WITH ACT—REMEDY—PENALTY.] § 21. In case any sanitary district in this State formed under the provisions of this act shall introduce sewage into any river or stream of water, or natural or artificial water-course, beyond or without the limits of such district, without conforming to the provisions of this act, or having introduced such sewage into such water-course, shall fail to comply with any of the provisions of this act, an action to enforce compliance shall be brought by the attorney-general of this State in the courts of any county wherein such water-course is situate, or he may authorize the State attorney of any such county to commence and prosecute such action in any such county: *Provided*, That nothing in this section contained shall be construed to prevent the prosecution of any action or proceeding by individuals or bodies corporate or politic against such district.

207. ACT—HOW CONSTRUED.] § 22. Nothing in this act contained shall be so construed as to constitute a contract or grant between the State of Illinois and any sanitary district formed under its provisions, or to prevent, debar, or deprive the State of Illinois from at any time in the future altering, amending, or repealing this act, or imposing any conditions, restrictions, or requirements other, different, or additional to any herein contained upon any sanitary district which may be formed hereunder.

208. CHANNEL—HOW TO BE CONSTRUCTED.] § 23. If any channel is constructed under the provisions hereof by means of which any of the waters of Lake Michigan shall be caused to pass into the Des Plaines or Illinois River, such channel shall be constructed of sufficient size and capacity to produce and maintain at all times a continuous flow of not less than 300,000 cubic feet of water per minute, and to be of a depth of not less than fourteen feet, and a current not exceeding three miles per hour, and if any portion of any such channel shall be cut through a territory with a rocky stratum where such rocky stratum is above a grade sufficient to produce a depth of water from Lake Michigan of not less than eighteen feeet, such portion of said channel shall have double the flowing capacity above provided for, and a width of not less than one hundred and sixty feet at the bottom capable of producing a depth of not less than eighteen feet of water. If the population of the district draining into such channel shall at any time exceed 1,500,000, such channel shall be made and kept of such size and in such condition that it will produce and maintain at all times a continuous flow of not less than 20,000 cubic feet of water per minute for each 100,000 of the population of such district, at a current of not more than three miles per hour, and if at any time the General Government shall improve the Des Plaines or Illinois rivers, so that the same shall be capable of receiving a flow of 600,000 cubic feet of wa er per minute, or more, from said channel, and shall provide for the payment of all damages which any extra flow above 300,000 cubic feet of water per minute from such channel may cause to private property so as to save harmless the said district from all liability there-

from, then such sanitary district shall, within one year thereafter, enlarge the entire channel leading into said Des Plaines or Illinois rivers from said district to a sufficient size and capacity to produce and maintain a continuous flow throughout the same of not less than 600,000 cubic feet of water per minute, with a current of not more than three miles per hour, and such channel shall be constructed upon such grade as to be capable of producing a depth of water not less than eighteen feet throughout said channel, and shall have a width of not less than one hundred and sixty feet at the bottom. In case a channel is constructed in the Des Plaines River as contemplated in this section it shall be carried down the slope between Lockport and Joliet to the pool commonly known as the upper basin, of sufficient width and depth to carry off the water the channel shall bring down from above. The district constructing a channel to carry water from Lake Michigan of any amount authorized by this act may correct, modify, and remove obstructions in the Des Plaines and Illinois rivers wherever it shall be necessary so to do to prevent overflow or damage along said river, and shall remove the dams at Henry and Copperas Creek in the Illinois River, before any water shall be turned into the said channel. And the canal commissioners, if they shall find at any time that an additional supply of water has been added to either of said rivers, by any drainage district or districts, to maintain a depth of not less than six feet from any dam owned by the State, to and into the first lock of the Illinois and Michigan Canal at La Salle, without the aid of any such dam, at low water, then it shall be the duty of said canal commissioners to cause such dam or dams to be removed. This act shall not be construed to authorize the injury or destruction of existing water-power rights.

209. CHANNEL, WHEN COMPLETED—CONTROL OF.] § 24. When such channel shall be completed, and the water turned therein, to the amount of three hundred thousand cubic feet of water per minute, the same is hereby declared a navigable stream, and whenever the General Government shall improve the Des Plaines and Illinois rivers for navigation, to connect with this channel, said General Government shall have full control over the same for navigation purposes, but not to interfere with its control for sanitary or drainage purposes.

210. MAY PERMIT TERRITORIES OUTSIDE TO DRAIN, ETC.] § 25. Any district formed hereunder shall have the right to permit territory lying outside its limits and within the same county to drain into and use any channel or drain made by it, upon such payments, terms, and conditions as may be mutually agreed upon, and any district formed hereunder is hereby given full power and authority to contract for the right to use any drain or channel which may be made by any other sanitary district, upon such terms as may be mutually agreed upon, and to raise the money called for by any such contract in the same way and to the same extent as such district is authorized to raise money for any other corporate purposes: *Provided*, That where the united flow of any sanitary districts thus co-operating shall pass into any channel constructed within the limits of the county wherein such districts are located, and which passes into the Des Plaines or Illinois rivers, such united flow shall in no case and at no time be less than 20,000 cubic feet of water per minute for each one hundred thousand of the aggregate of the population of the districts co-operating: *Provided*, Nothing in this act shall in any wise be so construed as to diminish, impair, or remove any right or rights of any city, village, township, or corporation, body politic, or individual situated on the Des Plaines or Illinois rivers or their tributaries and within the valleys of the same to use the channel for drainage or otherwise not inconsistent with the rights of the district constructing the same as expressed in this act.

211. WHEN CITY OR VILLAGE OWNS WATER-WORKS, ETC.] § 26. Whenever in any such sanitary district there shall be a city, incorporated town, or village which owns a system of water-works and supplies water from a lake or other source which will be saved and preserved from sewage pollution by the construction of the main channel, drain, ditch, or outlet herein provided for, and the turning of the sewage of such city and district therein, and there shall be in such sanitary district any territory bordering on any such city, incorporated town, or village, within the limits of another city, incorporated town, or village, which does not own any system of water-works at the time of the creation of such sanitary district, then, upon application by the corporate authorities of such latter named city, incorporated town, or village, the corporate authorities of such city, incorporated town, or village having such system of water-works shall furnish water at the boundary line between such municipalities by means of its water-works to the corporate authorities asking for the same, in such quantities as may be required to supply consumers within said territory, at no greater price or charge than it charges and collects of consumers within its limits for water furnished through meters in like large quantities.

212. WHEN CHANNEL CONSTRUCTED—COMMISSIONERS TO BE APPOINTED TO INSPECT ITS WORK.] § 27. If any channel shall be constructed under the provisions of section 23 of this act, it shall be the duty of the trustees of such district, where such channel shall be completed, and before any water or sewage shall be admitted therein, to duly notify, in writing, the governor of this State of such fact; and the governor

shall thereupon appoint three discreet persons as commissioners, one of whom shall be a resident of the city of Joliet, or between said city and the city of La Salle, and one a resident of the city of La Salle, or between said city and the city of Peoria, and one a resident of the city of Peoria, or between said city and the mouth of the Illinois River, to inspect said work. The said commissioners shall within ten days after such appointment meet at the city of Chicago, and shall appoint a competent civil engineer, and they may employ such other assistants as they may require to expeditiously perform their duties. The said commission shall take as their datum line for the survey the datum established by the Illinois and Michigan Canal Trustees in 1847, and shall make such examination and surveys of Chicago River and of the channel or channels authorized by this act as shall enable them to ascertain whether said channel is of the character and capacity required by this act. And in case they shall find the work in all respects in accordance with the provisions of section 23, of this act, they shall so certify to the governor, who shall thereupon authorize the water and sewage to be let into said channel. But in case said commissioners shall find said channel is not constructed in accordance with the provisions of this act, it shall be their duty to file in any court of competent jurisdiction, on the chancery side thereof, in their name as such commissioners, a bill against said corporation, which bill shall set forth wherein said work is deficient and fails to comply with the provisions of this act; and said court shall thereupon issue an injunction without bond against said defendant, enjoining and restraining it from admitting water or sewage into said channel, until the final order of the court. And in case said court, upon hearing, shall determine that said channel is not constructed in accordance with the provisions of this act, said injunction shall be continued until the provisions of this act shall have been fully complied with.

Such commissioners and engineer shall receive for their services ten dollars per day each, and their reasonable expenses and outlays for the time by them necessarily employed in the discharge of their duties, which shall be paid to them from the State treasury; and the said sanitary district shall re-imburse the State for all expenses and disbursements on account of said commission.

If any channel is constructed under the provisions of this act which shall discharge the sewage of a population of more than 300,000 into or through any river beyond or without the limits of the district constructing it, the same shall be constructed in accordance with the provisions of section 23 of this act, and if any such channel receives its supply of water from any river or channel connecting with Lake Michigan it shall be construed as receiving its supply of waters from Lake Michigan.

UNITED STATES.—IMPROVEMENT OF THE ILLINOIS AND DES PLAINES RIVERS.

Section.
18. Repeal.
19. Works ceded to the United States on condition.
20. Conditions—removal of dam.
21. Basis of act of cession.

AN ACT in reference to the improvement of the Illinois and Des Plaines rivers, and to repeal an act entitled, "An act to cede certain locks and dams in the Illinois River to the United States," approved May 31, 1887; in force May 31, 1887. Approved June 4, 1889; in force July 1, 1889.

18. REPEAL.] § 1. *Be it enacted by the people of the State of Illinois represented in the general assembly*, That an act entitled, "An act to cede certain locks and dams in the Illinois River to the United States," approved May 31, 1887; in force May 31, 1887, and ceding the State works at Henry and Copperas Creek, and the pools created by said works, to the General Government upon certain conditions as to the opening of a water-way of a depth of seven feet from the Mississippi River to Lake Michigan, upon plans to be determined by United States engineers, is hereby repealed.

19. WORKS CEDED TO THE UNITED STATES ON CONDITION.] § 2. That the State works at Henry and Copperas Creek, and the river now slackwatered by said works, are hereby ceded to the United States, on condition that the dams shall be removed whenever the depth now available for navigation can be secured and maintained by channel improvement without the aid of said dams: *Provided*, That said depth shall be assured upon the removal of said dams, or that such removal shall not materially impair navigation.

20. CONDITIONS—REMOVAL OF DAM.] § 3. That in the event of the non-acceptance of these works upon the conditions mentioned in section 2, within four (4) years after this act becomes a law, the Canal Commissioners of the State of Illinois are authorized and instructed to remove the dams at Henry and Copperas Creek.

21. BASIS OF ACT OF CESSION.] § 4. That the State of Illinois bases this act of cession upon the condition that the plan of improving the Illinois River below La Salle by slackwater maintained by dams and locks, be changed to a plan of improvement by means of an open channel in conjunction with a water supply from Lake Michigan.

[This act is in place of sections 18 and 19, on page 1321, Hurd's Revised Statutes, 1887.—ED.]

JOINT RESOLUTION.

Whereas the present addition to the low-water volume of the Illinois River through the summit level of the Illinois and Michigan Canal from Lake Michigan more than doubles the volume of water used in the estimate of 1868 for the channel below Peru, and adds 50 per cent. to the volume used in the estimate of 1880 for the channel below Copperas Creek, and said contribution from Lake Michigan will be increased in the immediate future, thus enabling the depth now projected for navigation below Peru to be obtained by channel improvement at moderate cost, and with decided advantage to material interests and to healthfulness along the valley.

Whereas it is contemplated to increase the volume from Lake Michigan to 300,000 cubic feet per minute within a few years, and ultimately to add 600,000 cubic feet or more, thus enabling a large depth for navigation to be obtained by an improved channel, and that said channel will be self-sustaining and self improving and will discharge flood waters more readily, thus benefiting the bordering lands and increasing the healthfulness of the valley;

Whereas works now projected by the city of Chicago will form part of a water-way of large porportions from Lake Michigan via the Des Plaines and Illinois rivers to the Mississippi River, of which the dams and locks upon the alluvial section of the Illinois River can form no part, and which, if allowed to remain, will increase, overflow, and be detrimental to the welfare of the Illinois Valley and the interests of the State: Therefore, be it

Resolved by the senate, the house of representatives concurring herein, (1) That it is the policy of the State of Illinois to procure the construction of a water-way of the greatest practicable depth and usefulness for navigation from Lake Michigan via the Des Plaines and Illinois rivers to the Mississippi River, and to encourage the construction of feeders thereto of like proportions and usefulness. (2) That the United States is hereby requested to stop work upon the locks and dams at La Grange and at Kampsville, and to apply all funds available and future appropriations to the improvement of the channel from La Salle to the mouth with a view to such a depth as will be of present utility and in such manner as to develop progressively all the depth practicable by the aid of a large water supply from Lake Michigan at Chicago. (3) That the United States is requested to aid in the construction of a channel not less than 160 feet wide and 22 feet deep with such a grade as to give a velocity of 3 miles per hour from Lake Michigan at Chicago to Lake Joliet, a pool of the Des Plaines River immediately below Joliet, and to project a channel of similar capacity and not less than 14 feet deep from Lake Joliet to La Salle, all to be designed in such manner as to permit future development to a greater capacity.

PRELIMINARY REPORT OF THE DRAINAGE AND WATER SUPPLY COMMISSION OF THE CITY OF CHICAGO.

JANUARY, 1887.

To the City Council of the City of Chicago:

GENTLEMEN: One year ago you passed a resolution recommending the mayor to appoint a drainage and water supply commission to consist of an expert engineer of high reputation, and one or two consulting engineers, to consider and report a system for supplying the citizens with pure water and for draining the territory of the municipality. In the preamble to said resolution, you stated that this community demanded a system "adequate to meet requirements, not only for the present, but of years to come, and that no temporary expedient or make-shift would satisfy them."

With a feeling of grave responsibility, I at once entered upon the duty of finding an engineer of such standing and reputation that his opinion and report would command the respect of this community. I corresponded with distinguished engineers and skilled men throughout the country. After careful inquiry I selected Mr. Rudolph Hering, of Philadelphia, as the one having the necessary qualifications. The congratulations of many experts and of the scientific press coming to me, lifted from me a cloud of anxiety.

Subsequently I appointed as one of the consulting engineers Mr. Benezette Williams, who had been largely commended as being well fitted for the first place. Mr. Samuel G. Artingstall, city engineer, was directed to co-operate with and aid, as far as was consistent with his other duties, the commissioners. His aid and advice was so valuable that I determined to appoint him a second consulting engineer, so that he might reap the credit earned, and might also feel his full share of the responsibility.

The painstaking care of the commission; its absolute impartiality in studying the past with the many suggestions handed down by it; its honest industry in the in-

vestigation of every valuable hint given it; its determination to obey the implied command of the preamble to your resolution, and its labors in furtherance of that command, has relieved me of still further anxiety, and gives me confidence that the people of Chicago, certainly the thinking ones, both of the present and of future decades, will thank you for your timely action and will justify me in what I have done in following your recommendations.

A full report from the commission would have been very desirable at the present time, for a mere preliminary report may arouse criticisms which a full one would silence, but your resolution made this present report absolutely necessary; and a final report at the present time is not possible. I therefore hand you herewith a preliminary report made sufficiently full to enable such wise legislation as may be necessary to be enacted.

I commend it to your careful study, and suggest that you yourselves consult with the engineers so that you may fully comprehend their suggestions, and may better understand what is to follow. Being in constant consultation with the chief of the commission, and studying the breadth and scope of what is being done, I am fully persuaded that the money already expended and what will be needed, is but a bagatelle when compared with the value of the final report which will be laid before you within the next six months. To make such final paper requires no further surveys or physical investigations of any magnitude, but will be a thorough sifting of gathered facts and scientific deductions, which will permit a collation of all data with reasonable accuracy as to cost.

You will find that the commission in its endeavor to solve the problem submitted to it for solution, has not gone into the field of discovery nor attempted anything novel or startling. Its conclusions in many features have been more or less advocated by many for years. But such advocacy was rather the result of unskilled guesses or brainy hypotheses, than of scientific research and mathematical calculation. Wiseacres will say aloud: "Why all this expense and dely? We knew all this before." They mistake, they did not know it, they guessed it. The commission have examined many hypotheses, discarding the worthless, and proving the truth of the true ones, and will show how they can be made possible of being carried out.

Money has been spent, not wasted, as is asserted by a newspaper this morning. The majority of men believe the planets to be inhabited, yet nations would spend countless millions to prove the fact and to learn how and by whom.

The preliminary report advises no temporary make-shift or expedient, but a plan not for the present, but for long years to come, if not for all time; not for our present population, nor for such as most cities could expect in many decades.

The commission has carefully studied Chicago, its past and its future, and for the latter has examined the city's invironments and vast surroundings with scientific precision. Comparisons have been instituted with regard to the growth of other cities in this and other lands. Conclusions have been reached from rigid data, and not from speculative dreams. These conclusions demand a drainage of a territory which will be the great Chicago of the future, whether it be called one city or may have several suburban names.

This great city, or cluster of city and suburbs, will require a drainage of 600,000 cubic feet per minute, for two reasons: First, to insure pure water for domestic use of its people; second, that no pollution will be sent towards the Mississippi to be an intolerable nuisance to the cities and people along the line of the Desplaines and Illinois rivers.

The cost of this vast undertaking will be great, more than the district to be drained can possibly, under existing organic law, undertake. You should bear in mind that this great expenditure will be necessary only for the great future city, with its population of 2,500,000, and need not be expended for a number of years, but will be ultimately demanded. The present expenditure will be in the proper direction as a necessary part of the great final work, and will of itself permit pure water to be taken from the lake within 2 miles from the shore, as suggested by the report. To build the great canal is an undertaking which should be national or State. It is the scheme dreamed of by the fathers of the nation when, in the last century, they resolved that Lake Michigan and the waters between it and the Mississippi and the carrying places or portages should be for the use of the people forever and free from all tolls. The great engineer who laid out the beds to be filled by rivers, and the shores of seas and lakes, traced with absolute certainty the line of a deep canal of river size from Chicago to the Desplaines which should marry the waters surrounded by 5,000 miles of lake shore line to the 12,000 miles of navigable waters which make up the Mississippi system.

To-day there are distant rumblings of possible war between this country and England, and mighty interests are alarmed by the exposures made by scientific men of the ease with which this and other lake cities may be blown into atoms by British gunboats before this country can be ready for war. If this canal, necessary for Chicago drainage, were now finished, gun-boats could be rapidly built which could lock up in

the Welland Canal England's navy, whereas to build now a single gun-boat capable of reaching Lake Erie would be a declaration of war.

Government should build this canal, and should commence it at once, and through its building unload itself of the idle hundred millions in its vaults, which should be giving work and bread to industrious laborers, and by the aid of such canal placing itself in a position which would not bring a blush of shame to the American cheek by a repetition of the Mason and Slidell fiasco.

If the Government will not build it, then Illinois, with its proud position of third State in the Union, owing not a dollar of debt, should do the work. If the State, blind to its interests, refuses, then Chicago should not supinely call upon national or State Hercules for help, but should put its own shoulder to the wheel; should demand of the State the privilege and power to do the thing, and should build the mighty work. It should do that itself which is necessary for its health and comfort, even if by so doing it frees the nation from periodic scares by enabling it to build gun-boats which would hold the keys to the Welland Canal. It should finish the work itself, even though by doing so it would give the Northwest a river capable of floating great steamers between the lakes and the Mississippi, carrying on a mighty trade, and worth more to the people in governing railroad traffic and lessening extortions than a dozen interstate commerce bills.

The canal, if built by Chicago, could be made free from all tolls, except, perhaps, very small ones for care and maintenance of locks.

Mr. Hering has made calculations which convince him that the rental of water-power along the canal would, at the rate charged at Minneapolis, pay interest upon the bonds necessary to build the canal, and would create a sinking fund to pay off said bonds; that is, at Minneapolis rates the water-power would be worth from $1,500,000 to $2,000,000 per annum.

Illinois, then, in the midst of richest grain fields of the world, close to the cotton fields of the South, with a climate in which white men can work without exhaustion, would be the first manufacturing State in the Union.

But suppose neither Government nor State will do this mighty work, and refuses to give the city the power to undertake it, what then is left for us to do?

The commission shows you, on page 35 of the report, that a part of this great plan can be carried through at a cost of from $5,000,000 to $5,500,000, which will give relief until the city shall have reached a population of over 1,000,000, possibly of 1,100,000.

The commission, in obedience to your command, shows in this report the great comprehensive scheme, of which this latter is alluded to as a part, and a necessary part.

The final report will show that by carrying out this part only the sewage can be disposed of at the last-named cost in such manner that the city, with over 1,000,000 population, will be in better condition than it is at present with the facilities of which we are now possessed, but that after that the pollution of the river will rapidly increase as the city attains a greater population. Between now and then something may be hoped for from Government or State.

The final report will also show details of work which may be completed by the city less comprehensive than the one recommended in obedience to the command of the preamble in your resolution, but yet giving the city the power to obtain relief, and which will be within the financial power of the drainage district as such district shall grow in population. These matters were not and should not be set forth in the preliminary report. That part of the plan alluded to on page 35 of the report, and calculated to cost from five to six millions, however, will be a prerequisite, and must be undertaken whether the work shall be pushed further or not.

If after this part of the work has done the good claimed Chicago shall be still left to do the remainder, she will not be without means of relief. The present valuation of property within the proposed metropolitan drainage district at present rates is not far from $200,000,000. This will give a basis for $10,000,000 of bonds. The real valuation is over $800,000,000, and is rapidly increasing.

Before the work on any large scale can be completed the assessed valuation at present rates will, perhaps, reach $300,000 000, furnishing a basis for $15,000,000 bonds. The commission recommends a channel from here down the Des Plaines to carry off 600,000 cubic feet per minute, ample for a city of from 2,500,000 to 3,000,000 population. But a flow of 300,000 feet per minute will be ample for a population of over 1,500,000, giving to the city perfectly pure water from the lake and reasonably pure water to the people along the Des Plaines and Illinois Rivers. This can be brought about for six-tenths of the cost of the whole. That is, if the 600,000 feet flow will cost $20,000,000, the 300,000 feet flow will cost $12,000,000.

This will not give us a grand navigable river, but a deep channel sufficient to permit the Government to hold the keys of the Canadian canals, and it will be sufficient for a mighty city, and the grown-up Chicago of the future will then be able to undertake the grand scheme here recommended; for it is easier for a greater city to do a great work than for a simply great one to do it. A 300,000 per minute flow can be increased to a 600,000 flow, but at more than a proportionate cost.

The commission lays before you a solution of the engineering problem. To carry it out, even in its initial steps, requires a solution of a financial problem. It is suggested by some that the five to six millions necessary to the first step which is within our grasp, be raised by special assessments. With all due respect for those favoring this idea, I must differ with them most earnestly. Some people have an almost fanatic hostility to issuing bonds. A vast portion of the property to be assessed is wholly unproductive, and can not be made otherwise for years to come. It is valuable, but its value is entirely speculative. It has no productive value for any present purpose. It is comparatively worthless except for future city lots. To lay heavy special assessments upon such property with only a distant future return, will force the owners to the wall, or place them at the mercy of rich capitalists. This work, while beneficial to the present Chicago, will be vastly more beneficial to the future metropolitan district. That future should pay for it. Fifteen hundred thousand people twenty years hence can pay the debt with far less than half the difficulty that the present population would meet with.

Legislation will be necessary to grasp either horn of the dilemma. A law should be enacted to create the new metropolitan district with power to issue bonds or levy assessments as the law may fix, and to prosecute the work. It should be controlled, not by several commissioners but by one able well-paid head, to whom the people can look for honesty and fidelity, and who can be held for any shortcoming. Let us not be alarmed lest he be of some party not our own. I would a hundred fold prefer an honest, responsible person for the head of the affair, opposed to me in politics than to a commission of several good men, the majority of whom were of my own party. If the governor be the appointing power we can hold him responsible for a good selection, and his appointee responsible for his every act.

It is earnestly to be hoped that our skilled thinking men will bury past prejudices, will lay aside preconceived notions, and all without jealousy or pride of option, unite in one common effort to bring about a full solution of all needful questions. A beam which supports a mighty weight is but the united strength of thousands of fibers which singly could be snapped between the fingers.

CARTER H. HARRISON,
Mayor.

CHICAGO, *January*, 1887.

To the honorable Mayor and City Council of the city of Chicago:

GENTLEMEN: On January 27, 1886, your honorable body passed a resolution authorizing the creation of a drainage and water-supply commission. After being amended February 23, it read as follows:

"Whereas, Pure water and scientific drainage are necessities of this community, and the people demand a system of water supply and drainage adequate to meet the requirements not only of the present, but of years to come, nor will any temporary expedient or make-shift satisfy them; and

"Whereas, A thorough and permanent system of supplying pure water to our citizens and caring for the drainage of the municipality can not be paid for out of current taxation, therefore it is desired that a plan shall be devised and perfected before the next meeting of the legislature, to the end that necessary legislation may be had.

"For the purpose of carrying into effect the objects sought, there is recommended the appointment by the mayor of a commission to consist of one expert engineer, whose reputation is so high that his opinion and report will command the respect of the community, and with him one or two consulting engineers of like experience in engineering and sanitary matters. The duty of this drainage and water-supply commission, made up as above set forth, should be to consider all plans relating to drainage and water supply which may be brought to its attention; to make such examinations and investigations and surveys as may be deemed necessary; to collect all information bearing on this problem; to consider all recent developments in the matter of sewage disposal, and their application to our present and future needs; to consider and meet necessity of increasing our water supply and of protecting the same from contamination; to remedy our present inadequate methods of drainage and sewage disposal; to consider the relations of any system proposed to adjacent districts, and whether there may not be a union between the city and its suburbs to solve the great problem, to determine the great question as to the interest which the State and the United States may have in the disposal of sewage by way of the Illinois River, and to devise plans to meet any objections thereto, if such a system shall be thought best; and in general to consider and report upon any and all things which relate to the matter of water supply and drainage of the city of Chicago.

"The commission should report on the whole matter committed to it in the most full and comprehensive manner, with maps, plans, and diagrams complete, and accom-

pany the report with estimates of the first cost and annual requirements for the maintenance of the system proposed.

"The report of the commission should be made as early as practicable, and not later than the convening of the next session of the Illinois legislature in January, 1887.

"In consideration of the foregoing, be it

"*Resolved*, That the mayor be, and is hereby, authorized and directed to employ on behalf of the city one expert engineer of reputation and experience in engineering and sanitary matters, at a salary not to exceed $10,000 per annum, and also to employ such consulting engineers, not exceeding two in number, as may seem necessary, and such assistant engineers as may be required, all to be paid according to services rendered, for the purpose of carrying out the objects set forth in the preamble hereto. For the fees of said assistant engineers and for all expenses connected with said work there shall be allowed not to exceed the sum of $20,000. All fees, salaries, and expenses connected with said work shall not exceed in the aggregate the sum of $30,000, and the same shall be paid from the water fund of the city upon vouchers audited by the mayor and city comptroller."

In accordance with the terms expressed herein his honor Carter H. Harrison appointed Rudolph Hering as chief engineer, Benezette Williams and S. G. Artingstall as consulting engineers, who, together, should constitute a commission. Mr. Hering entered upon duty March 28, Mr. Williams September 17, and Mr. Artingstall, December 21, 1886.

The investigation designated by the resolution was a formidable one, comprising no less a task than the consideration of the entire subject of the future water supply and drainage of Chicago. It appeared doubtful from the beginning that a report such as was demanded could be furnished within the specified time, for the simple reason, if for no other, that observations of the lake phenomena and of the flow of certain rivers should be extended over at least one year, covering four consecutive seasons, in order to draw satisfactory deductions.

But the large amount of work alone that was asked for made it impracticable to present a complete report in so short a time. It was expected, however, that results could be reached sufficient to indicate the character of legislation required to carry out any project that might be determined upon, and that therefore a preliminary report having this end in view could be made at the stated time, leaving to a later date the presentation of a report outlining the detailed features of the scheme recommended and embracing the minor results of the entire inquiry.

The present communication is to cover the ground indicated for the preliminary report, and besides containing the conclusions reached regarding the main features of the proposed project, it contains also a brief review of the work done during the past year and of what still remains to be done.

The month of April was devoted to a general examination of the subject, of the territory to be investigated, and of the various suggestions that had been made toward effecting a solution of the problem.

The examination disclosed the fact that the city is sometimes greatly suffering from the offensive condition of parts of the Chicago River and its branches caused by the discharge of sewage into the same, and from the occasional contamination of its water supply, brought about by the discharge of the polluted contents of the river into the lake. It also disclosed the fact that almost every conceivable way of dealing with these questions had been suggested and in some forms applied during the past thirty years.

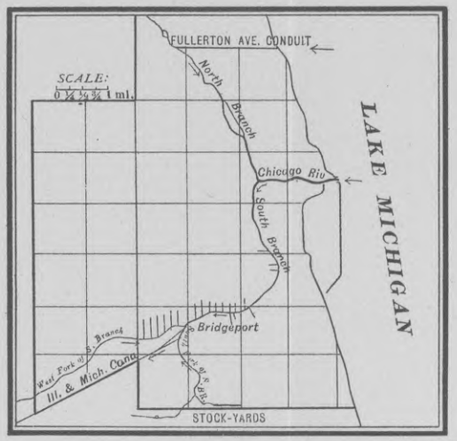
The problem therefore demands the attainment of two ends; the protection of the water supply and the removal of the river nuisance. As the water must be taken from the lake, it is evident that both its pollution and the objectionable condition of the rivers should be prevented by a better disposition of the sewage. It is therefore the latter question which constitutes the main object of this investigation.

Among the possible methods of getting rid of the Chicago sewage there are but three that have been deemed worthy of an extended consideration, namely; a discharge into Lake Michigan, a disposal upon land, and a discharge into the Desplaines River. The preliminary work has therefore been confined to these three projects, and was classed as topographic, hydrographic, and miscellaneous.

At the time when the present commission began its labors the topographical work had already received some attention. Surveys were being made of the Desplaines River from Bridgeport westward under the direction of Mr. Artingstall, city engineer. These surveys were continued, and have now been completed as far as Joliet. They include contours of the entire valley and borings to rock between Bridgeport and Lemont. In order to understand the hydrography of the Desplaines Valley above the point where the Chicago sewage could be discharged into it, and also to ascertain the probable magnitude and effect of floods in the river, a survey was made of its bed as far north as Northfield township. To determine the area of the basin its entire divide was located. To ascertain the practicability of diverting the flood waters from the upper portion of the Desplaines and North Branch water-sheds directly into the

PROPORTION OF SEWAGE AND LAKE WATER IN THE CHICAGO RIVER.

When the entire flow is into the Illinois and Michigan Canal.



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lake, and thus avoiding the difficulties which would arise from their passing through the Chicago River, all feasible lines were surveyed. Finally, a few levels were taken of the area adjoining the city wherever no connected levels existed to show the general topographical features of the territory over which the future city will spread out and from which the drainage will require artificial removal.

The hydrographic work consisted in ascertaining the flow of the Desplaines River, the rain-fall upon its area, its flood discharges, the character of its bed, and the probable effect of discharging the Chicago sewage into it when diluted by a large and constant stream of water from the lake. It consisted, further, in examining the nature of the currents in the lake and in studying the rise and fall of its level, and in ascertaining the amount and character both of the sewage discharged into it and of the deposits in the river and lake in front of the city, to determine the effects of the present sewage disposal.

Inquiry and surveys were made to show the feasibility of purifying the Chicago sewage by filtration on land. Land damages were carefully estimated for the different schemes; existing records were searched concerning borings and excavations made in and about the city, so that the practicability of certain lines of tunnels could be discovered; the probable growth of the city and its suburbs, as well as the probable distribution of the future population, received a careful attention; and finally, a large number of data were compiled which pertain to the existing works of water supply and sewerage in Chicago and the adjoining towns.

In reporting the result thus far gained, we will present them in the order most convenient for discussion, but before doing so will briefly describe the present manner and effect of the sewage disposal, as shown by this investigation.

PRESENT SEWAGE DISPOSAL.

The sewerage works of Chicago and suburbs have been planned on what is called the combined system, in which the sewers serve for the removal both of sewage and rain-water. In the town of Evanston they empty into the lake. In the town of Lake View they partly discharge into the lake and partly into the North Branch. From the north and west divisions and part of the south division of Chicago the drainage enters the Chicago River and its branches, and from the remaining part of the south division it flows into the lake at three outlets, situated respectively at Twelfth, Twenty-second, and Thirty-fifth streets. The sewers of Hyde Park discharge into the lake, excepting those of Pullman, where the sewage is disposed of on land. The town of Lake, including the stock-yards district, drains into the South Fork of the Chicago River.

When the sewerage works of this city were designed, in 1856, by Mr. E. S. Chesbrough, it was apprehended that ultimately some means would have to be found to change the water in the river from time to time or to keep the sewage entirely out of it. The first step toward improving the condition of the river was taken by deepening the Illinois and Michigan Canal, so as to cause a current from the lake to the Desplaines River at Lockport. The next step was the building of the Fullerton Avenue conduit in order to produce a circulation in the North Branch; and the last step was the erection of the canal pumping works to increase the flow in the river, which had become greatly polluted.

The influence of these works is confined to the main river and its North and South Branches. But the South Fork of the latter, receiving a large amount of sewage from Chicago and the town of Lake, and charged with the waste from the Union Stock-Yards and packing houses, has no artificial means for a circulation of its water, and as a consequence is in a condition of great filthiness.

The accompanying diagram has been prepared to show the present pollution of the Chicago River and its branches during the time when all of their water is discharged into the canal by the Bridgeport pumps. On the left are shown the main river and the North Branch, one above the other, their combined waters forming the South Branch, and reaching Bridgeport on the right, where they are lifted into the canal. At the latter point the South Fork is shown as joining it. The shaded portions indicate the amount of sewage entering and passing the respective points, and the blank portions the lake water diluting it. The degree of dilution is shown by the relative areas. It diminishes in the North Branch from Fullerton avenue to the South Branch, and becomes still less toward Bridgeport, and finally receives the foul waters of the South Fork.

The depth and character of sewage deposits in the river and harbor, as might be expected, vary considerably. They are not great in the track of the vessels, but increase towards the docks and quieter portions of the slips, where they reach a depth of from 1 to 4 feet. While the deposits in the channel are of a heavier kind, such as cinders, those in the docks are mostly a foul mass of decomposing organic matter. No form of life is found to exist above Clark Street Bridge as far north as Claybourn Place and as far south as Ashland avenue. The effect of this condition of the river

is to endanger the purity of the water supply whenever the river, with its accumulated deposits, flows into the lake, which occurs when the rain-water that finds its way into the river exceeds the amount pumped into the canal. If this excess is great, as in the spring and occasionally in the summer months, the contamination of the lake is considerable, and must constantly increase.

From the foregoing it is seen that the present method of disposal of the sewage from Chicago and its suburbs is partly by discharging it into Lake Michigan, but mainly, except during floods, by discharging it into the Desplaines River.

FUTURE POPULATION.

The first question which required an answer, and upon which many of the subsequent inquiries depended, was the population which it is economical and advisable to consider at present, and the extent of territory upon which such a population will be located.

The growth of Chicago has been frequently quoted as phenominal. Estimates made thereof for various purposes have turned out to be rather under than over the actual result.

It is taken for granted that Chicago and its suburban towns will have to dispose of their sewage so that the water supply for the entire community residing near the lake from the south line of Hyde Park to the north line of Evanston will be guarded against pollution by the sewage from any one of the separate communities. For this purpose the whole populated area within the above limits is considered as forming one city with a common interest.

The growth of this metropolis was obtained partly from the United States census and partly from the school census of Cook County, which give a record up to the summer of 1886. In order to forecast the probable ratio of the future increase, it was desirable to compare this growth with that of other cities. By considering the ratio of increase elsewhere, and including the natural suburbs of each city, a fair and instructive basis of comparison was obtained; and by realizing the respective natural advantages for growth in each of the communities the probable ratio for Chicago was determined with a satisfactory degree of exactness.

The accompanying diagram shows the results of this comparison. It represents by curves the population of the largest cities in the country since 1790, not as usually quoted from the census, giving the inhabitants on certain arbitrary areas fixed by law, but as virtually making up the population of the respective municipalities, by including adjacent towns and natural suburbs, the only method which enables the true growth of the great cities to be recognized. For instance, the New York center naturally includes Brooklyn, Jersey City, Hoboken, Newark, and other suburbs, and Chicago the entire territory from Hyde Park to Evanston.

The diagram indicates that the character of growth of the different cities permits them to be divided into two distinct classes. Philadelphia, Boston, St. Louis, and Cincinnati show very much the same character of increase, and represent by comparison the more conservative communities. New York and Chicago, on the other hand, while showing a remarkable resemblance to each other, form quite a contrast to the rest of the cities, and might be called the more progressive communities. The diagram finally indicates the time when the Chicago curve, which wa the lowest one prior to 1864, intersected in turn those of St. Louis, Cincinnati, Boston, and there is a high degree of probablity of its intersecting the Philadelphia curve in or before 1891, *i. e.*, in four years from now, after which Chicago will be the second largest center of population in America.

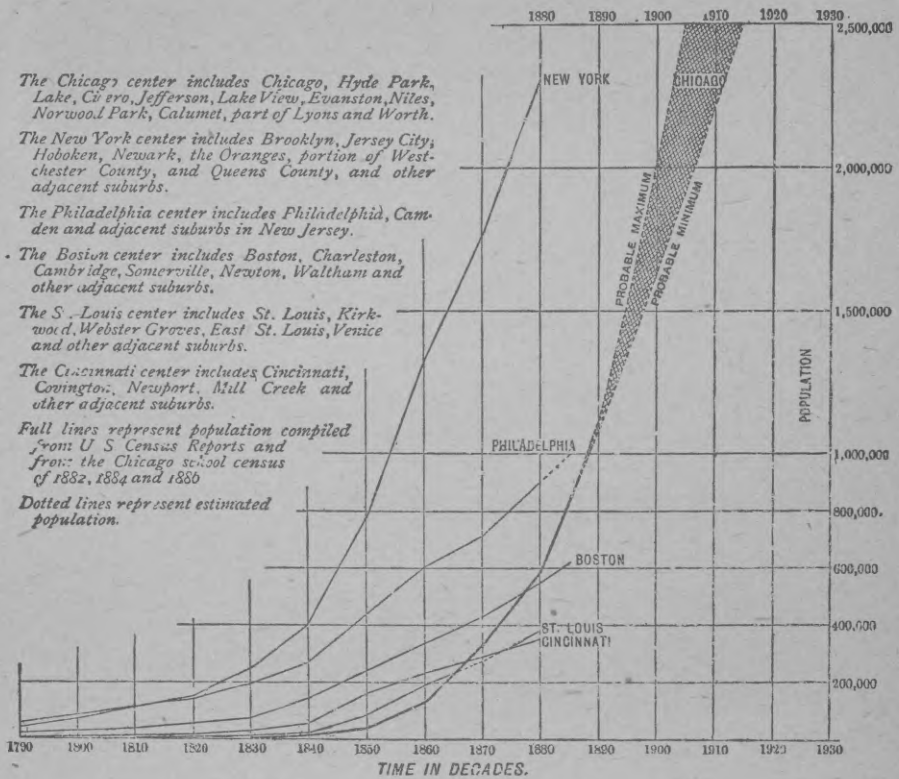
As it is not practicable in so young a city as Chicago to forecast a definite line of growth, it is preferred to give the probable minimum between which the true line will most likely be contained. The minimum line represents a growth resembling that of New York, and the maximum line assumes the ratio of increase per decade to be constant instead of gradually decreasing as in most other cities. The result indicates that the population of Chicago and suburbs will be two and a half millions between the years 1905 and 1915, or about three times the present population in eighteen to twenty-eight years.

In providing public works for large communities it must be borne in mind that it is economical to invest only such sums as will bring a return within a certain number of years, leaving expenditures for benefits that will be realized only at a later time to a later generation. This fact, together with the probable growth of Chicago, shows it to be economical and judicious at present to plan works sufficiently extensive to dispose of the sewage of not less than 2,500,000 inhabitants.

In addition to the population the area that will be occupied by it has to be determined. While this is a far more difficult task, owing to the many accidental causes influencing the distribution of the population, it is possible nevertheless to outline the area sufficiently close for present purposes.

The future metropolis, with a population three times as great, will be distributed along the lake from South Chicago to Evanston, and will reach inland to the Blue Island ridge in the south to the Des Plaines River in the center, and to the higher parts of Niles Township in the north. Outside of these general limits a more or less dense population will extend for some distance along the lines of railroads.

GROWTH OF SEVERAL POPULATION CENTERS IN THE UNITED STATES.



As inferred above, it is proper to consider at this time the wants of the population that will reside upon this entire territory.

DISCHARGE OF THE SEWAGE INTO LAKE MICHIGAN.

To discharge the sewage from cities into comparatively large bodies of water is not only the usual, but often the best method for its disposal. Dilution and dispersion thoroughly expose it to the action of the oxygen contained in both the water and the superincumbent air, and it is thereby gradually oxidized. Where the body of water is a large river with a strong current, the best conditions for such purification are found. Where it is a lake in which the circulation is slight and irregular, the efficacy of the method is less and depends for its success on the character of the currents and the relative amount of sewage to be discharged into it.

The hydrographic surveys of the lake made during the past season were therefore partly for the purpose of ascertaining, if possible, the laws governing the currents, so that we would know their effect in dispersing the sewage discharged into the lake. The trend of the shore currents was actually ascertained by daily recording the direction of spar-buoys placed at the Chicago water-works crib, at Michigan City, and at St. Joseph. A large number of bottle-floats were thrown into the lake at different points and different times for the same purpose. They were partly single surface floats and partly double, the lower one being placed at varying depths according to the depth of the water. More than half of them have been picked up and returned, with

place and date noted. The currents were also observed by means of large car-buoys from an anchored tug-boat at different points in the lake, extending from Hyde Park to Evanston, about six miles from the shore. And two general lake trips were undertaken, one to St. Joseph and back to Grosse Point, and another one parallel with the shore around the head of the lake.

When the observations are completed and compiled in detail some valuable information will be available for the question of water supply. Light will be thrown on the movement of the water under different winds and the sudden changes of temperature of the water at the crib and on the turbidness of the same.

The following results have a bearing on the question of sewage disposal. Where not affected by local conditions the currents practically go with the winds in water of moderate depth and quickly respond to any change. In deep water also the surface currents run with the wind, but at the bottom and even at mid-depth the direction is usually different. The prevailing current along the shore of Cook County during the past summer has been observed to be toward the north, but it is possible that this result may be different during the winter months. In the open lake wave action seems to be effective in preventing the permanent deposits down to a depth of about 60 feet; inside of the breakwater sewage deposits are found on the bottom.

The general deduction from these results is clear that, as no constant current exists which would carry the sewage away in one direction, it should be discharged into the lake at one end of the future city, while the water supply should be obtained as far away from it as practicable toward the other end; a conclusion which is being acted upon in the other large lake cities. The proper place from which to bring the water would be opposite Grosse Point, and the sewage discharge should be east of Hyde Park. While it might be practicable to allow the sewage in its crude form to enter the lake under such conditions for many years, the necessity would arise later for clarifying it at least partially previous to its discharge. It could not be allowed to run into the rivers as at present, but the dry weather flow and a considerable amount of storm water would have to be intercepted and carried to the outfall through many miles of special conduits. And this entire quantity would have to be raised by pumping in order to get sufficient head to empty into the lake, while the diluted sewage during storms, in excess of the capacity of the intercepting sewers, would be allowed to discharge directly into the river.

The water supply would have to be brought from Grosse Point in large conduits to the several pumping stations scattered over the city and its present suburbs. The circulation of the water in the Chicago River and branches would have to be maintained practically as it is at present, because the removal merely of the dry weather flow of sewage would not altogether prevent its pollution.

DISPOSAL OF LAND.

We shall not at this time enter into a general discussion of the principles underlying land purification of sewage, or make historical references showing the success or ill-success of the method as practiced elsewhere. We will simply state that with good management under ordinarily favorable conditions a disposal on land proves satisfactory, so far as the purification of the sewage is concerned, and that with proper conditions in the way of good markets and a favorable soil and climate sewage farms can be operated on a large scale after the sewage is delivered upon the same without financial loss.

In speaking of a sewage farm of the magnitude required for the metropolitan area of Chicago, it is not understood as being land devoted primarily to the raising of crops, using the sewage only when and where it would most promote the growth of vegetation. The primary object would be the purification of the sewage on an area of land as small as could serve the purpose. Technically speaking, the sewage disposal would be by means of intermittent filtration rather than irrigation. To carry out such a scheme for Chicago involves the following:

(1) The acquirement of sufficient land suitable for the purpose.

(2) A comprehensive system of intercepting and collecting sewers carrying the sewage to the farm.

(3) Pumping-works of a capacity to handle all the dry-weather flow of sewage and a certain proportion of storm water.

(4) A thorough underdrainage, leveling, and preparing of beds for the filtration areas.

(5) A system of underground conduits and surface carriers for distributing the sewage over the ground, and a system of open ditches for removing the purified water to the nearest water-courses.

(6) Buildings, roads, and a complete farming outfit.

(7) An organization for properly distributing the sewage, for carrying on the farm-

ing operations, and for conducting the business of disposing of the crops in the best market.

In making estimates for the size of intercepting sewers, conduits, pumps, and area of land required, we have used as a basis a population of 2,500,000 people, with an average dry-weather sewage discharge of 150 gallons, or 20 cubic feet, per head daily, and made provision for storm-water equivalent to one-fifth of an inch in twenty-four hours over all portions of the district now drained, or likely to be drained, by a combined system of sewers, allowing surplus-water to escape into the rivers and lakes.

The dry-weather flow of sewage would therefore be 50,000,000 cubic feet per day, and the maximum flow of storm-water 65,000,000 cubic feet per day, making a total maximum discharge of 115,000,000 cubic feet.

From an examination of rain-fall tables we conclude that the annual amount of storm-water that would be carried off by such an intercepting system would range from 9 to 12 inches, an average of which in round numbers may be taken at 40,000 cubic feet per acre per annum over the area drained by a combined system of sewers. It is practicable, however, to exclude the storm-water from the sewers over a large portion of the future city by adopting the separate system of sewerage. The area north of the town of Jefferson and of the middle of Lake View may be treated to advantage in this way, and also a large portion of Hyde Park, Lake, Calumet, and other adjoining towns.

Assuming that the area which does not allow the storm-water to be entirely excluded is 140 square miles, the average daily amount becomes 10,000,000 cubic feet, which gives, when added to the sewage, 60,000,000 cubic feet, or 24 cubic feet per head of population per day to be provided for on the farm.

As the amount of land required to purify sewage can only be determined by experience, and as this has been very limited in our own country, we are forced to rely mainly upon that of Europe. Without going into details at present, we will simply state that a fair consensus of this experience justifies us in the conclusion that from 10,000 to 15,000 acres of land would be required to dispose of the sewage from the entire metropolitan area.

The only available territory for sewage filtration in the neighborhood of Chicago consists of two sandy ridges in the town of Thornton, extending across the State line into Indiana, and in a sandy ridge crossing the town of Niles. The soil is quite favorable, but the character of the surface is such that the necessary preparation to make it suitable for filtration-beds would be comparatively expensive. An enormous cost is, however, represented by the fact that the sewage would have to be collected by large intercepting sewers, lifted altogether some 90 feet and carried about 20 miles before reaching the farms. We therefore consider such a project entirely impracticable.

The land treatment can only be seriously thought of in connection with the sewage disposal from the smaller areas mentioned above and comprising the extreme northern and southern parts of the future metropolis. The drainage of parts of Evanston, Lake View, and Niles might be taken to the sandy ground in the latter town, and that of the Calumet region to the sandy ridges in Thornton, should this method be found most advantageous when compared with others.

The preliminary investigation made for this purpose consisted in an examination of the grounds, in the projection of a farm, and in an estimate of the cost of preparing the same and delivering the sewage to it by intercepting sewers and conduits.

DISCHARGE OF THE SEWAGE INTO THE DES PLAINES RIVER.

A third solution of the drainage problem is rendered practicable by the fact that the divide between Lake Michigan and the Mississippi Valley lies about 10 miles west of Chicago, with so slight an elevation that it is not a difficult matter to carry the sewage from the city westward into the Des Plaines River, and thence into the Mississippi River. This method of disposal, as previously explained, is in fact mainly the present one, most of the sewage now being carried across the divide by the Illinois and Michigan Canal.

There are two low depressions between the future metropolis and the Des Plaines River—the Mud Lake Valley, with the present canal, and the Sag Valley, west of Lake Calumet. Neither is more than 10 feet above the lake, nor do they present any engineering difficulties for canal construction. It is therefore quite feasible to carry all the drainage from the territory ultimately to be occupied by the metropolis, extending from Lake Calumet to Evanston, into the Mississippi Valley through these depressions, avoiding thereby all possible lake pollution, and permitting the supply of water to be drawn from any number of convenient points in front of the city.

The possibility of this solution was recognized as early as 1856 by Mr. E. S. Chesbrough, and the first step toward its adoption was taken, as already mentioned, by turning the sewage into the Illinois and Michigan Canal. Not until quite recently,

however, has it become practicable to consider the construction of a special water-way for sewage removal, because when the population was smaller the expense of the undertaking was too great.

The sanitary requirements demand a flow of water large enough to dilute the sewage sufficiently to make it inoffensive along the river at all times. Beyond this, any increase in the size of the channel to provide for the storm-water which naturally enters it, should be kept at a minimum. A glance at the map and an examination of the ground show the possibility of diverting the greater part of the storm-water from the metropolitan district without serious difficulty. Both branches of the Calumet River can be diverted west of the Indiana State line into Wolf Lake, and thence into Lake Michigan. The Des Plaines River can have its flood waters diverted into the North Branch near the north line of the town of Jefferson, and the combined waters can be led from Bowmanville directly into the lake. Salt Creek, a branch of the Des Plaines River, can readily be turned southwardly near Western Springs, through a water-course known as Flag Creek, at one time evidently its old bed, discharging into the Des Plaines, opposite Sag, and thus reducing the necessary storm-water capacity in the new channel between Sag and Summit.

In order to determine the probable quantity of flood water which can thus be excluded, it was necessary to ascertain the maximum flood discharges from all the water-sheds in question. This requirement called for a gauging of Des Plaines, North Branch, and Calumet Rivers, a gauging of the rain-fall, which is a measure of the stream-flow, a survey of the water-sheds, and an examination of the river channels. It was also necessary to make a reconnaissance of all possible lines for diverting the Des Plaines, the North Branch, the Calumet Rivers, and Salt Creek, and a survey of those which were most important.

The results indicate that each one of these diversions is both practical and economical. By adopting the "separate system" of sewerage for the territory lying north of the proposed Bowmanville Channel, the surface drainage from this territory can be safely turned into the lake.

A second branch of the investigation extends to the elements governing the proper size for the water-way from which a large proportion of the storm-water has been excluded. The area still draining into it will consist largely of paved streets and roofs, allowing of no absorption and shedding the water rapidly. It requires a careful consideration to determine the maximum quantity of water that may enter the proposed channel, and for which an ample allowance must be made to prevent a back flow of the polluted water to the lake.

The proper degree of sewage dilution in the new channel demanded a careful investigation. When sewage is mingled with a sufficiently large quantity of water it not only becomes inoffensive, but readily finds the oxygen which gradually purifies it. When the surface is covered with ice a greater dilution is necessary for this purpose than at other times when there is a constant replenishment of oxygen from the air. The proposed water-way should of course provide immunity from offense at all times.

The information upon which definitely to decide this question will be given in the final report, as the data have not yet been all collected, owing to the necessity of making actual tests of the oxidization of the canal water under the ice, which is being done for the use of the Commission by Dr. J. H. Rauch, secretary of the State board of health. The summer conditions are presented in his late report on the water supply and sewage disposal of Chicago. The result of these analyses will be compared with those of other streams that are also polluted with sewage in order to show the rate of oxidization with varying degrees of dilution and aeration.

For the purpose of estimating the cost of the water channel we have assumed 3,600 square feet for the cross-section and a velocity of the water 3 feet per second, or 2 miles per hour. This gives a discharge of 600,000 cubic feet of water per minute, or 24,000 cubic feet for each 100,000 persons, which we believe equal to the maximum requirements of a population of 2,500,000 people.

A third branch of the inquiry covers the selection of routes for the proposed canals.

Between Chicago and Summit three lines are practicable; one following the West Fork and Ogden Ditch, and another extending from the southwestern end of the South Fork in a westerly direction to the Ogden Ditch, and thence to Summit, and a third being an enlargement of the present canal. We are of the opinion that eventually both the first and second of these lines should be adopted, but that the second one should be built first in order to secure circulation in the South Fork. From Summit westward the bed of the river and the present canal were the only lines to be considered. The best location has not yet been finally determined.

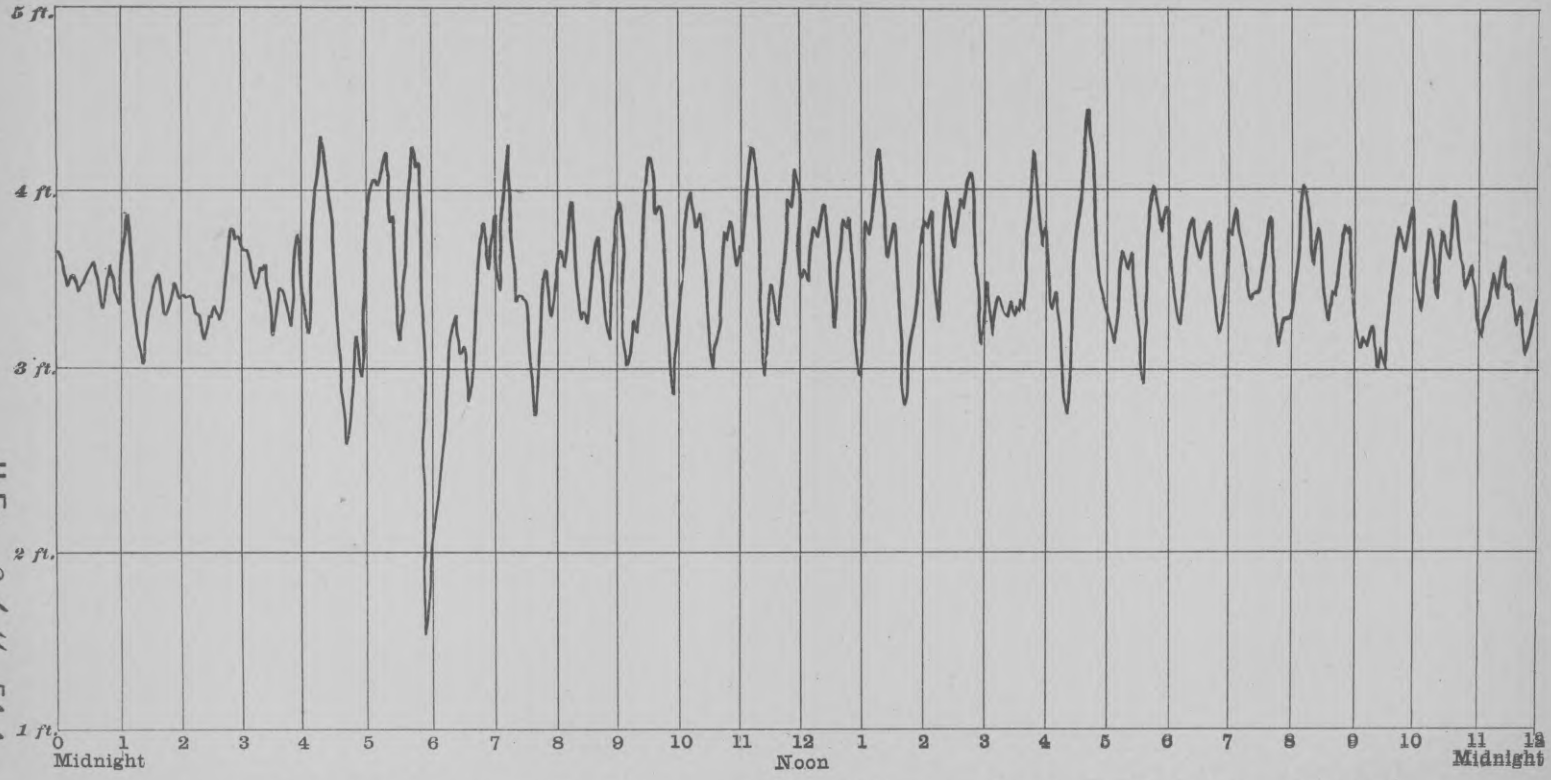
For the drainage of the Calumet region a simple inspection shows that a canal should start from the river at the southern point of Blue Island, and extend almost directly westward to the Des Plaines Valley at Sag.

A fourth branch of the inquiry relates to the study of such data as have reference to securing a proper circulation for the water-ways within the city.

FLUCTUATIONS OF THE WATER SURFACE OF LAKE MICHIGAN

AS RECORDED BY AN AUTOMATIC GAUGE

AT CHICAGO, ILLINOIS, AUGUST 16th, 1886.



NOTE.—Early in the morning an area of Low Barometer passed over Lake Michigan eastwardly, at the rate of 55 miles per hour. At 3 P. M. it was central at Buffalo. The wind at Chicago was from N.W. in the morning, shifting to S.W. in the afternoon. Chicago datum is extreme low water.

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To throw light upon this point the variations of the lake-level have been recorded since last spring by means of an automatic gauge, indicating an almost continual fluctuation, averaging several inches and recurring at periods of about twenty minutes. During a low pressure of the atmosphere the amplitude of these oscillations increases, and not unfrequently reaches several feet. The accompanying diagram shows the level of the lake on August 16, 1886, at a time when an area of low barometer passed over it. From 6.40 a. m. to 6.55 a. m.—that is, in fifteen minutes—the water fell 2 feet 10 inches.

A rising level causes an inflow to the river and drives the water of the latter into the slips, where it deposits a portion of its suspended sewage matter and becomes foul. A falling level reverses the flow, and the slips empty their foul water into the river and lake. During heavy fluctuations of the latter, such as the one referred to above, it has been traced more than a mile in the direction of the crib.

As the proposed canal from Bowmanville to the lake will lower the water of the north branch at this point to the lake-level, provision must be made for its circulation. The size of the Fullerton avenue conduit is not sufficient to furnish the water required for a current in both directions, nor would such an arrangement be satisfactory or economical. It will be necessary to establish a flow toward the south branch from the lake opposite Bowmanville in order to prevent a future lake pollution by the proposed channel. This can be accomplished by placing a lock in the north branch at any point that may be found most desirable, and raising the water at the same time about 1 foot. If such a lock is placed at Fullerton avenue the present pumping-works, with slight modifications, can be utilized.

Finally, it must be mentioned that circulation can be secured in the proposed water-ways of the Calumet region, into which the sewage is discharged, by a gravity flow from Lake Michigan into the Des Plaines Valley through Lake Calumet and the Sag. The detailed features of this project have not yet been wholly matured, the estimates of cost being based on a channel having a capacity of 1,000 cubic feet per second.

COMPARISON OF PROJECTS.

In the foregoing we have outlined the main features of the only three feasible methods of disposing of the metropolitan sewage, and have given the results of the investigation reached to date. A general conclusion as to the preferable method may be given at present, and also an approximate estimate of cost. But we are not able as yet to give either conclusions or detailed statements of the probable expense regarding all parts of the proposed work, and must defer them until the final report.

In comparing the projects we will first mention their probable cost and then their relative advantages.

The discharge of the sewage into the lake from a population of 2,500,000 in the manner described above, including the extra expense, otherwise not necessary, of taking the water supply at Gross Point, would cost at least $37,000,000, with an annual expense for interest and operation of at least $2,400,000. It would require an immediate investment of about $20,000,000.

To dispose of the entire metropolitan sewage by filtration on land would require an investment of about $58,000,000, with an annual expense of over $3,000,000, for interest, pumping, and maintenance, after deducting the profit from the sale of crops. It would be necessary to invest at once about $34,000,000. Land disposal for the sewage from the Calumet region alone, with a future population of 300,000, would require an investment of about $4,000,000, and an annual expense of at least $250,000.

Finally, the cost of the Des Plaines project is approximately estimated as follows:

(1) A channel from the South Fork to Joilet, of the capacity heretofore given, will cost between $17,000,000 and $21,000,000.

(2) A diversion of the flood waters of the Des Plaines, the North Branch, and Salt Creek will cost between $2,500,000 and $2,800,000.

(3) Pumping works and locks for the North Branch will cost about $150,000.

(4) A separate system of sewers to collect the sewage now discharged directly into the lake and to carry it into the river will cost about $600,000.

(5) A channel from Lake Calumet to Sag will cost between $2,500,000 and $3,000,000.

(6) A diversion of the flood waters of the Calumet river will cost between $350,000 and $400,000.

The total cost of the Desplaines drainage project would therefore be for the main district between $20,250,000 and $24,550,000; for the Calumet district, between $2,850,000 and $3,400,000. The annual cost, including interest, etc., is estimated at about $1,300,000 per annum.

The pollution of the lake can be decreased and the present condition of the Chicago

River, and particularly of the South Fork, can be improved by the immediate construction of the following works, which, with the exception of the pumping works at the South Fork discharging into the Illinois and Michigan Canal, are all a part of the final plan.

(1) Channels diverting the flood waters of the Desplaines, North Branch, and Salt Creek, as described above.

(2) A modification of the Fullerton Avenue pumping-station and the construction of locks for the purpose of getting circulation in the North Branch.

(3) A separate system of sewers to collect the sewage now flowing into the lake from the south division and to discharge it into the South Fork.

(4) A water-way extending from the western end of the South Fork to the Illinois and Michigan Canal with a new pumping-station, to promote circulation.

(5) By raising the banks of the canal and by removing deposits its capacity can be increased 40 per cent. at a small cost, and thus provide for a greater flow of water in the same.

The cost of the works comprised under these five items is estimated to be between $5,000,000 and $5,500,000. They could be finished in three years, and would greatly lessen the liability of polluting the water supply, while the sewage would be disposed of in the best practicable manner until the final completion of the Desplaines project.

It therefore appears that this project is decidedly the least expensive one for the present as well as for the future.

Besides the economical advantage of the Desplaines scheme, its superiority is still further emphasized by advantages of another kind. The proposed canal will, from its necessary dimensions and its regular discharge, produce a magnificent water-way between Chicago and the Mississippi River, suitable for the navigation of boats having as much as 2,000 tons burden. It will establish an available water-power between Lockport and Marseilles fully twice as large as that of the Mississippi River at Minneapolis, which will be of great commercial value to the State. The Calumet region will be much enhanced in value by having a direct navigable channel to the Desplaines River, and by a lowering of the flood heights of Calumet Lake and River. Within the city the water of the Chicago River and its South Branch will get a much better circulation if it flows by gravity than if it has to be pumped, the necessity for which would remain even if the sewage should be discharged through intercepting sewers either into the lake or upon land. Under either of the latter conditions an occasional overflow from the sewers into the river during heavy rains would be more objectionable than a constant discharge of sewage into a more rapidly-flowing stream. Flood waters entering the lake by way of the Chicago River would carry into it much filthy matter, either suspended or deposited, notwithstanding the existence of intercepting sewers; but the proposed diversion of such waters before reaching the populated districts will for all time obviate this undesirable occurrence. Lowering the level of the North Branch at Bowmanville by its diversion to the lake will be equivalent to raising the low prairie extending toward Evanston and Niles, and greatly benefit parts of these towns.

THE WATER SUPPLY.

In reaching the conclusion that the sewage of the city should be discharged into the Mississippi Valley the question of water supply is materially simplified, because the lake will then at all times furnish good water wherever intakes are desired for an extension of the works.

The preliminary inquiry, made with a view to ascertain the main features of an increased supply, comprised first a compilation of data concerning the exisiting works both in Chicago and its suburban towns, which were collected mainly through the courtesy of the respective authorities; and, secondly, a study into the most economical method of distributing the water over the metropolitan area. The following is a brief description of the existing works:

The present intake for the public water supply of Chicago is located in Lake Michigan about 2 miles from shore, and the water is conducted to the city in two circular brick tunnels 5 and 7 feet in diameter. They extend parallel to each other under the bed of the lake, and 50 feet apart, to the north pumping works, where they are connected and where the 5-foot tunnel terminates. The 7-foot tunnel is continued under the city for a distance of 20,500 feet, to supply the west works, on Ashland avenue, near Twenty-second street.

The tunnels from the source to the shore are built at a depth of 80 feet below city datum, or low water in the lake, and the 7-foot tunnel is continued on the same level for a distance of about 11,500 feet, where, to avoid rock excavation, it is inclined upward until, at the west pumping station, the top is but 21 feet below city datum. The economical capacity of the two tunnels is between 90,000,000 and 100,000,000 gallons per day, or less than the present average daily consumption of water. Their maximum capacity is reached when delivering about 150,000,000 gallons per

day, which is now nearly equaled by the demand during the hours of greatest consumption, and, at the present rate of increase, it is estimated that during the summer of 1887 the maximum demand for water will be at the rate of 145,000,000 gallons per day; during 1888, 155,000,000 gallons per day; during 1889, 167,000,000 gallons per day, and in 1890, 180,000,000 gallons per day.

To provide against accident or obstruction from ice or other cause in the main tunnels, and to provide against an inadequate supply in the near future, which appeared inevitable, a new tunnel is in progress of construction. The intake is located 1,500 feet from shore, and connection is made with the other tunnels at the north pumping works.

The distribution of the water is effected by pumping it directly into the water mains at the north and west stations. At the north works the three tunnels are so arranged and constructed that any one of them can be emptied when desired for repairs or cleaning, and both the pumping stations still be supplied with water from the other tunnels. The total pumping capacity of this station is at present 67,000,000 gallons per day, but it will be increased to 91,000,000 gallons per day as soon as the new pumps now in process of erection are in operation.

The connections between the pumps, stand-pipes, and the distribution mains at these works have become so complex by the successive additions to the plant that an unnecessary loss of head is the consequence. As this can be remedied to some extent without great expense, we recommend that it be done at the first favorable opportunity. The station, being on the shore of the lake, is not centrally located with reference to any part of the city, which renders it necessary to use a greater length of main pipe with a consequent loss of pressure to reach the consumers, than would otherwise be the case. The total pumping capacity of the west-side station is 60,000,000 gallons per day, and the connections between the pumps, stand-pipes, and mains are simple and effective, and the loss of pressure from this cause is a minimum. The location is better adapted to secure economical and satisfactory results than that of the north works, and with reference to additional pumping stations, which will later be necessary in other parts of the city, these works are well situated.

The following table, compiled from the annual reports for 1884 and 1885, gives a detailed comparison of the cost of pumping at two stations, anthracite coal being used at the north side and good bituminous coal at the west side:

Cost of pumping 1,000,000 *gallons one foot high.*

Nature of expenditures.	1884.		1885.	
	North side.	West side.	North side.	West side.
Salaries	$0.01488	$0.02022	$0.01560	$0.01667
Fuel	.05313	.02855	.04590	.02482
Lubricants	.00064	.00186	.00057	.00160
Miscellaneous	.00323	.00417	.00133	.00401
Total	.07188	.05480	.06340	.04710



The hydraulic merits of the system are shown on the diagram of water pressures from a survey made in December, 1886. The pressures have all been reduced to a common height above city datum and to a uniform height of water at the works. That diagram shows a greater loss of head in the vicinity of the North Side station than at the West Side. This is accounted for by the complex arrangements heretofore mentioned, and also by the relatively small area of mains, being only 16¼ square feet at the North Side and over 21 square feet at the West Side. Nearly equal quantities of water are pumped at each of the stations during the middle of the day.

The following table shows the pumping capacity of all the suburban towns having

a public water supply, and the pressure ordinarily maintained at the works. With the exception of South Evanston, all take water from Lake Michigan:

Locality.	Individual pump capacity.		Total pumping capacity per day.	Ordinary head at pump, in feet.
	Pumps.	Capacity per day.		
		Gallons.		
Hyde Park	2	3,000,000		
Do	1	12,000,000	18,000,000	103 to 150
Lake	2	4,000,000		
Do	2	2,000,000	12,000,000	100 to 190
Lake View	1	5,000,000		
Do	1	3,000,000	10,000,000	92
Do	1	2,000,000		92
Village of Evanston	1	3,000,000	3,000,000	92
Total	11		43,000,000	

At the artesian well supplying the village of South Evanston there is a head of about 53 feet.

The pressure at different parts of the pipe system is very irregular. In Hyde Park it varies from 165 feet at the pumps to 10 or 12 feet at Forty-third street. In the town of Lake the average head at the town hall is reported about 10 feet with 188 feet at the pumps. In Evanston, South Evanston, and Lake View the difference of head in various parts of the villages is not very great.

The following table gives a comparison of the consumption and cost of water in Chicago and the suburban towns:

Locality.	Year.	Average head at pumps.	Average daily pumpage.	Cost per million gallons, delivered.	Cost of pumping 1,000,000 gallons 1 foot high.
Chicago (North side)	1885	113	38,369,134	$7.17	$.06034
Chicago (West side)	1885	105	53,280,880	4.95	.04071
Evanston (village)	1886	113	787,000	17.00	.15000
Lake View	1886		1,983,000	11.85	
Lake	1886	163	7,292,023	8.80	.05400
Hyde Park	1886		3,410,000	8.92	

The second point of inquiry was a study into the most economical method of distributing the water over the metropolitan area. We will at present refer to it but very briefly, mentioning only such conclusions as pertain to the immediate demands, and leaving a fuller discussion of the details of this important question to the final report.

The comparatively level area upon which the city is located, and the practicability of taking the water from the lake along the city front at any desired point, after the sewage has been diverted, permits the most economical distribution to be ascertained by mathematical investigation to a much greater degree of exactness than is usually possible.

It is found to be less expensive for the densely populated areas to have pumping stations about two or three miles apart, because the loss of head and cost of mains and pumping to obtain the least allowable pressure are thus reduced to a minimum. In planning new works this fact should be considered, and locations so selected that they will be advantageous for the future as well as for the present.

The localities which we believe to be most suitable for additional pumping stations are: Near Twelfth street in the central part of the city, near the Union Stock-Yards, near Humboldt Park, and near Fullerton and Racine avenues.

When it is considered that at the present time the pumps are delivering during the busy part of the day at the rate of 120,000,000 gallons in twenty-four hours, which is nearly the maximum capacity of all the machinery, and that even with this large consumption of water it is impossible in some parts of the city to obtain water in the second story of the buildings, it becomes evident that an increased supply is imperatively required, and being a work of years to build new tunnels, inlets, buildings, and

machinery, the necessity of deciding upon the location for the new works as soon as possible is readily seen. The locality which is suffering most from the want of water is the business section and the south part of the city, the lowest pressure extending from Twelfth street to the city limits. It will become necessary in the future to have two stations in this territory, one between Harrison and Twelfth streets, and the other to be somewhere east of the Union Stock-Yards. We are strongly of the opinion that of the two stations it will be advisable and most advantageous to build the one north of Twelfth street first, for the following reasons:

(1) It will require a shorter tunnel from the lake to the proposed station, and less expenditure for main discharge pipes to connect with the present system than would be the case with the proposed southern station. This is equivalent to less cost and a saving of time in construction.

(2) If the southern station is built first it will require mains of larger capacity leading toward the city than will be ultimately necessary when the central station is built.

(3) The location recommended is near the center of the greatest consumption of water, and will be a gain not only in obtaining greater pressure in the business district, but in removing the cause for complaint on the South side by increasing the pressure so that the water will flow to the upper floors of the highest dwellings.

(4) All other parts of the city will gain by the construction in this location, as the North and West works will be relieved of the enormous drain upon them to supply water for the business part of the city. They will be better able to give a good head on the North and West sides, where the population is increasing very rapidly, and which will very soon be in the same unsatisfactory condition as now obtains in the southern end of the city, unless relief is afforded in the manner indicated.

The other pumping stations will gradually become necessary as the population increases, and for a population of 2,500,000 there will be a need for a total combined capacity of 375,000,000 gallons to provide for a daily consumption of 150 gallons per head. With several intakes and tunnels the danger from stoppage of the water supply by ice or accident will be reduced to a minimum, as it is not probable that more than one of them would be so endangered at the same time.

We believe that a submerged intake will afford a more reliable and safer structure so far as injury from passing vessels and stoppage by ice are concerned, than a structure projecting above the water.

With the sewage kept out of the lake there is no need of locating the intake further than two miles from the shore, where water can be obtained sufficiently free from suspended earthy matter, and where a depth of about 30 feet is generally found, which is the least depth desirable for a submerged inlet.

GENERAL REMARKS.

After presenting the results thus far gained, indicating the general solution of the Chicago drainage and water-supply problem, it remains to point out certain facts, which may be useful in discussing some of the legal measures required to carry out the proposed work. We desire to state that in order to reach the best results it is imperative to have all the main drainage-works, such as intercepting sewers, water-ways, and pumping stations, executed and maintained under a single management. It would be economical also to design and operate the main works for supplying water to the entire metropolitan area, on a uniform plan and under one management, for the same reason that it is economical to keep the north and west side pumping-works under one control, thus giving facilities as far as practicable for a supply, proportioned to the demand, to the entire metropolitan area, including the towns not bordering on the lake. We do not wish to imply, however, that such a general authority need necessarily extend further than to the construction and maintenance of the tunnels and conduits furnishing water to the respective pumping-works.

Regarding the limits for metropolitan drainage, the investigation has shown, as already indicated, that topographical conditions clearly define two districts for the future metropolis. The main district extends from the line of Eighty-seventh street on the south to the north line of Evanston, and from the lake westward to the Desplaines River. Its sewage is collected into one channel and discharged into the Desplaines Valley at Summit. The Calumet district extends over the natural drainage area of Calumet Lake and River, south of Eighty-seventh street, and has its outfall channel running from Blue Island to Sag.

The final report will contain several maps, showing certain features of the metropolitan area, namely, the distribution of the population in 1886, the existing works and main distribution pipes for water supply, and the existing main sewerage works and 5-feet contour lines over nearly the entire area. It will also contain maps and profiles of the proposed water-ways and storm-water diversion channels mentioned in the present report, and a map showing the lines of the main collecting and inter-

cepting sewers of the proposed drainage districts, and also the lines of new tunnels and the general distribution of the water supply.

In carrying on the present investigation its various branches were placed in charge of the following gentlemen, of whose ability and industry we desire to make special mention: Mr. L. E. Cooley, principal assistant, had special charge of the hydrographic work; Mr. Charles H. Swan, of the sewage disposal on land; Mr. Francis Murphy, of the topographical work; Mr. O. Guthrie, of the river pollution, land damages, etc., and Mr. T. T. Johnston, of the water-supply, sewerage, and miscellaneous work.

Respectfully submitted.

RUDOLPH HERING,
Chief Engineer.
BENEZETTE WILLIAMS,
SAMUEL G. ARTINGSTALL,
Consulting Engineers.

51ST CONGRESS, 1st Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. 264, Part 2.

SURVEY OF WATER-WAY FROM LAKE MICHIGAN TO ILLINOIS RIVER, AT LA SALLE, ILL.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

A letter of the Chief of Engineers, accompanied by twenty-six sheets of maps, which he recommends be printed to accompany the published report of Captain Marshall, as contained in House Ex. Doc. 264, present Congress, on the survey of a water-way from Lake Michigan to the Illinois River, at La Salle, Ill.

MARCH 24, 1890.--Referred to the Committee on River and Harbors.

WAR DEPARTMENT,
Washington, March 22, 1890.

SIR: In connection with my letter of the 11th instant, transmitting to the House of Representatives a report of Capt. W. L. Marshall, Corps of Engineers, upon a survey of the water-way from Lake Michigan to the Illinois River at La Salle, Ill., made under the provisions of the river and harbor act of August 11, 1888, I now have the honor to invite attention to the inclosed letter of the Chief of Engineers, of this date, transmitting twenty-six sheets of maps, which he recommends be printed to accompany the published report of Captain Marshall, as contained in House Ex. Doc. 264, of the present Congress, now understood to be in the hands of the Public Printer.

Very respectfully,

REDFIELD PROCTOR,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 22, 1890.

SIR: I have the honor to submit herewith blue prints of twenty-six sheets of maps, as specified below, intended to accompany report, dated February 28, 1890, of Capt. W. L. Marshall, Corps of Engineers, upon survey of a water-way from Lake Michigan to the Illinois River at La

Salle, Ill., forming part of a through route of transportation from Lake Michigan to the Mississippi River, required by river and harbor act of August 11, 1888.

Captain Marshall's report was transmitted from the War Department to the Speaker of the House of Representatives with letter of the 11th instant, and it is recommended that the accompanying maps be transmitted, with request that they be printed to accompany the published report as contained in House Ex. Doc. 264, Fifty-first Congress, first session, now understood to be in the hands of the Public Printer.

LIST OF ACCOMPANYING MAPS.

Routes between Joliet and Lake Michigan, via Chicago, and via Calumet or Sag Route (sheets 1 to 10, survey of 1888–'89, with index map).

Illinois River at Marseilles and Des Plaines River in the vicinity of Treat's Island from survey of 1888–'89 (2 sheets).

Des Plaines and Illinois Rivers from Joliet to La Salle, showing proposed location of locks and dams (sheets 1 to 6, survey of 1883, with index map).

Outline of water-way between Lake Michigan and La Salle, Ill., with proposed locations of locks and dams (plate I).

Several routes, with profiles, for that part of proposed water-way lying between Lake Michigan and Joliet (plates II, III, and IV).

Profiles of Des Plaines and Illinois Rivers, showing elevations of banks, bed, low water, high water, and proposed water surfaces (plate V).

Hydrographs of Illinois River from mean monthly gauge readings at Copperas Creek and La Grange, Ill., 1879–'89, inclusive (plate VI).

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

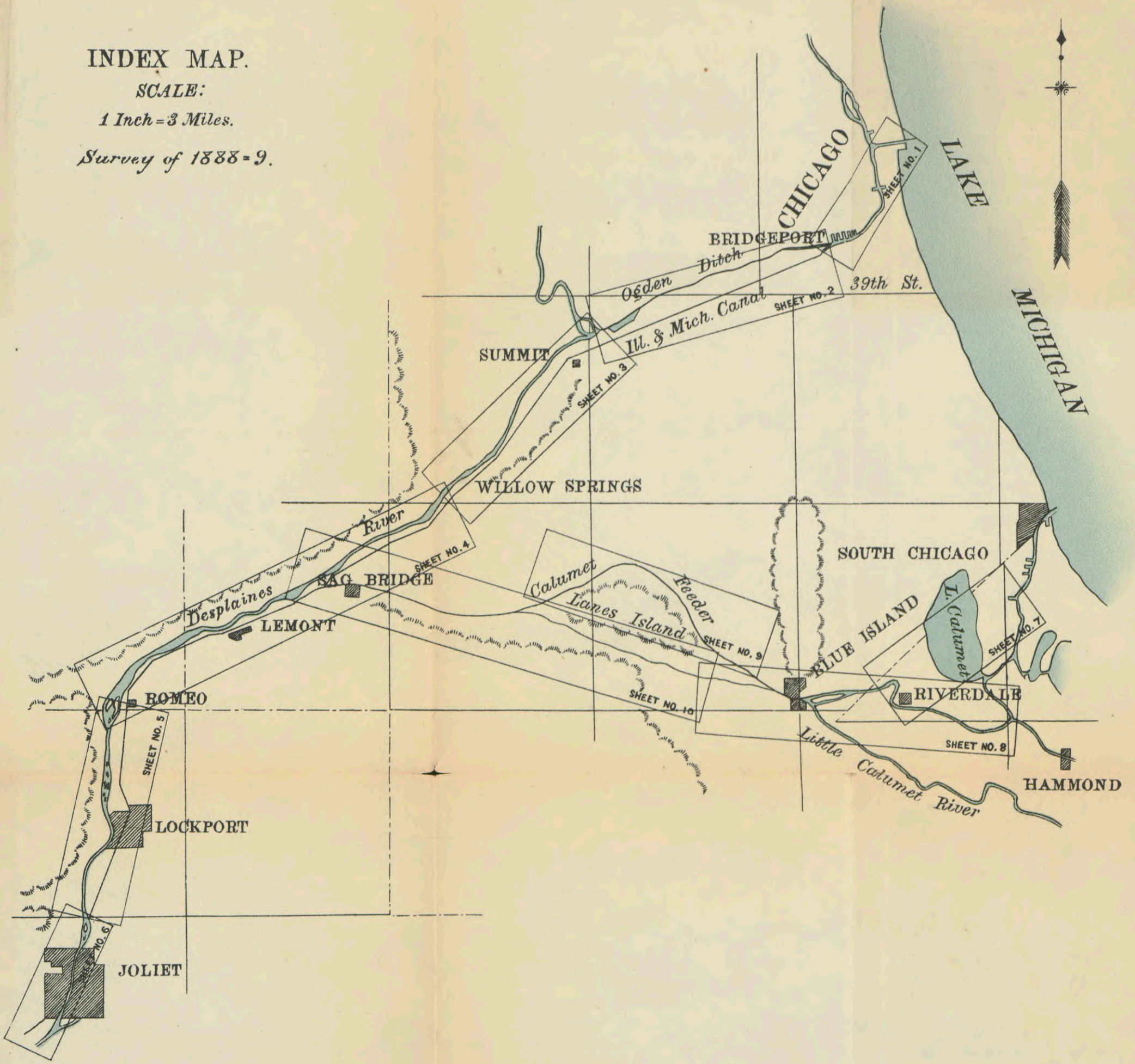
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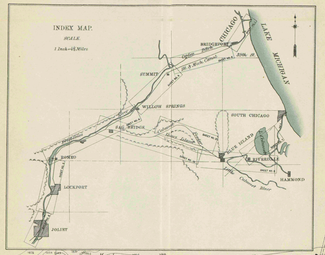
INDEX MAP.

SCALE:

1 Inch = 3 Miles.

Survey of 1888-9.





L A K E T O W N S H I P

L Y O N S T O W N S H I P

MAP & PROFILE

OF THE PROPOSED ROUTES FOR A

WATERWAY

BETWEEN

LAKE MICHIGAN & MISSISSIPPI RIVER.

Surveyed in Accordance with Act of Congress, August 11, 1888,
Under the Direction of

CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS, U. S. A.

BY

L. L. Wheeler, U. S. Assistant Engineer.

1888–1889

SHEET NO. 2

Scale for Map: 1 Inch = 600 Feet.

Scales for Profile: { Horizontal 1 Inch = 250 Feet.
Vertical 1 Inch = 9 Feet.

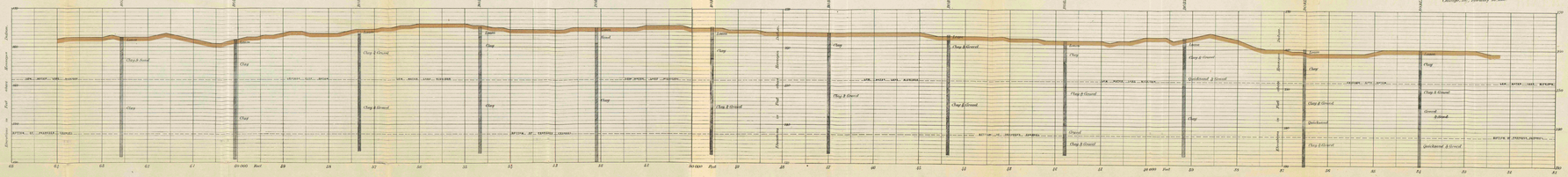
NOTES

The projection of this Map is based upon obstinal Bearth lines referred to True Meridian. Elevations are based upon Coast & Geodetic Survey bench marks and are 10 feet above Hennepin, Indiana, which is 143.5 feet below Low water of Lake Michigan (Chicago City Datum.) Location of Land Survey lines is only approximate. Soundings are referred to Low water of Lake Michigan.

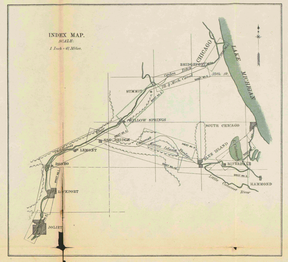
To accompany my report of this date upon the proposed Waterway between Lake Michigan and Mississippi River.

W. L. Marshall
Captain of Engineers.

Chicago, Ill., February 1st, 1889.



Forbes Co. Boston. H Ex 264 pt. 2 51



L Y O N S T O W N S H I P

MAP & PROFILE

OF THE PROPOSED ROUTE FOR A

WATERWAY

BETWEEN

LAKE MICHIGAN & MISSISSIPPI RIVER.

Surveyed in Accordance with Act of Congress, August 11, 1888,
Under the Direction of

CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS, U. S. A.

BY

L. L. Wheeler, U. S Assistant Engineer.

1888–1889

SHEET NO. 3

Scale for Map: 1 Inch=600 Feet.
Scales for Profile: { Horizontal, 1 Inch=1500 Feet. / Vertical, 1 Inch= 9 Feet.

NOTES

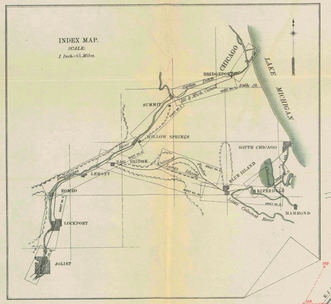
The projection of this map is based upon chestnut bronzed lines
referred to True Meridian. Elevations are based upon lines of
ordinary levels and are to (left above) Mississippi Datum, which is
111.1 feet below low water of Lake Michigan. (Chicago City
Datum.) Location of land during time to only approximate.

To accompany my report of this date upon the proposed
Waterway between Lake Michigan and Mississippi River.

Chicago, Ill., February 16 1889.

W. L. Marshall
Captain of Engineers.

FERRIS CO. BOSTON.



L O C K P O R T T O W N S H I P

MAP & PROFILE

OF THE PROPOSED ROUTE FOR A

WATERWAY

BETWEEN

LAKE MICHIGAN & MISSISSIPPI RIVER.

Surveyed in Accordance with Act of Congress, August 11, 1888,
Under the Direction of

CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS, U. S. A.

BY

L. L. Wheeler, U. S. Assistant Engineer.

1888—1889

SHEET NO. 5

Scale for Map: 1 Inch = 600 Feet.

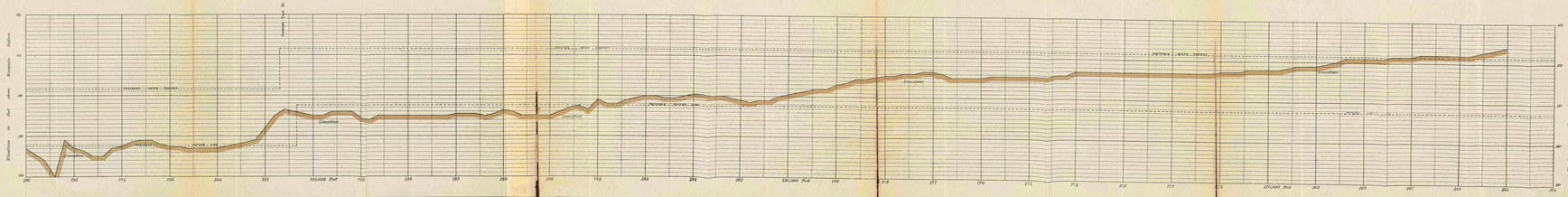
Scales for Profile: Horizontal, 1 Inch = 750 Feet. Vertical, 1 Inch = 3 Feet.

NOTES.

The projection of this Map is bound upon obscured Azimuth lines referred to True Meridian. Elevations are based upon Limit of ordinary levels, and are in feet above Sterrogate Datum, which is 111.1 feet below Low water of Lake Michigan. (Chicago City Datum.) Location of Land Surveying Scale is only approximate

To accompany my report of this date upon the proposed Waterway between Lake Michigan and Mississippi River.

Chicago, Ill., January 10, 1890. W. L. Marshall
Captain of Engineers.



H.E. 254 pt. 2 51

FORBES CO. BOSTON.

MAP & PROFILE

OF THE PROPOSED ROUTE FOR A

WATERWAY

BETWEEN

LAKE MICHIGAN & MISSISSIPPI RIVER.

Surveyed in Accordance with Act of Congress, August 11, 1888,
Under the Direction of

CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS, U. S. A.

BY

L. L. Wheeler, U. S. Assistant Engineer.

1888–1889

SHEET NO. 7

Scale for Map: 1 Inch = 600 Feet.
Scales for Profile: { Horizontal, 1 Inch = 750 Feet.
Vertical, 1 Inch = 9 Feet.

NOTES.

This Map is in part compiled from various sources and in part from original surveys. Elevations are based upon those of ordinary levels and are in feet above Hennepin Datum, which is 1113 feet below Low water of Lake Michigan. (Chicago City Datum). Soundings on Lake Calumet refer to a datum 1.5 feet above Low water of Lake Michigan.

LAKE

CALUMET

LITTLE CALUMET RIVER

WILDWOOD STA.

I.C.R.R.

C.R.I.&P.R.R.

M.C.R.R.

N.Y.C.&St.L.R.R.

V.V.C.&T.R.R.

CAL.R.R.

IRONDALE

CUMMINGS

BROWN'S IRON & STEEL WORKS

CALUMET RIVER

INDEX MAP.
SCALE:
1 Inch = 6 Miles.

LAKE MICHIGAN

CHICAGO

BRIDGEPORT

SUMMIT

WILLOW SPRINGS

SOUTH CHICAGO

ROBEY ST. BRIDGE

LEMONT

ROMEO

LOCKPORT

JOLIET

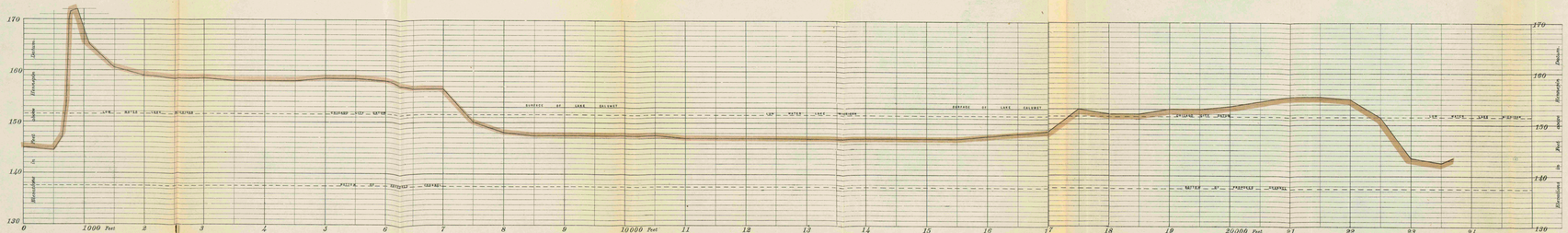
BLUE ISLAND

ROSELAND

HAMMOND

To accompany report of this date upon the proposed Waterway between Lake Michigan and Mississippi River.

Chicago, Ill., February 28, 1890. W. L. Marshall
Captain of Engineers.



Ex 264 pt 2 31

FORBES CO. BOSTON & N.Y.

MAP & PROFILE

OF THE PROPOSED ROUTE FOR A

WATERWAY

BETWEEN

LAKE MICHIGAN & MISSISSIPPI RIVER.

Surveyed in Accordance with Act of Congress, August 11, 1888,
Under the Direction of

CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS, U. S. A.

BY

L. L. Wheeler, U. S. Assistant Engineer.

1888-1889

SHEET NO. 9

Scale for Map: 1 Inch = 1000 Feet.

Scales for Profile: Horizontal 1 Inch = 750 Feet. Vertical 1 Inch = 8 Feet.

The projection of this Map is based upon chained Azimuth lines referred to True Meridian. Elevations are based upon those of ordinary levels and are in Feet above Mean-tide Datum, which is 553.5 feet below Low water of Lake Michigan. (Chicago City Datum). Location of Level Survey lines is only approximate.

To accompany my report of this date upon the proposed Waterway between Lake Michigan and Mississippi River.

Chicago, 28 February 16, 1890. W. L. Marshall, Captain of Engineers.

PALOS TOWNSHIP

WORTH TOWNSHIP

INDEX MAP.

SCALE

1 Inch = 11 Miles

LAKE MICHIGAN

CHICAGO

BLUE ISLAND

ROBEY

HARVEY

HOMEWOOD

FLOSSMOOR

THORNTON

CALUMET RIVER

CALUMET SUMP

CALUMET LAKE

CALUMET RIVER

LITTLE CALUMET RIVER

CALUMET RIVER

CALUMET RIVER

MARSEILLES

MAP & PROFILE
OF
ILLINOIS RIVER AT MARSEILLES, ILLS.

Surveyed in Accordance with an Act of Congress, August 11, 1888,
Under the Direction of

CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS, U. S. A.

BY

L. L. Wheeler, U. S. Assistant Engineer.

1888–1889

Scale for Map. 1 Inch = 300 Feet.
Scales for Profile: { Horizontal, 1 Inch = 750 Feet.
{ Vertical, 1 Inch = 9 Feet.

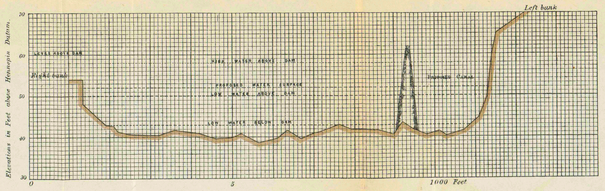
Feet.
Miles.

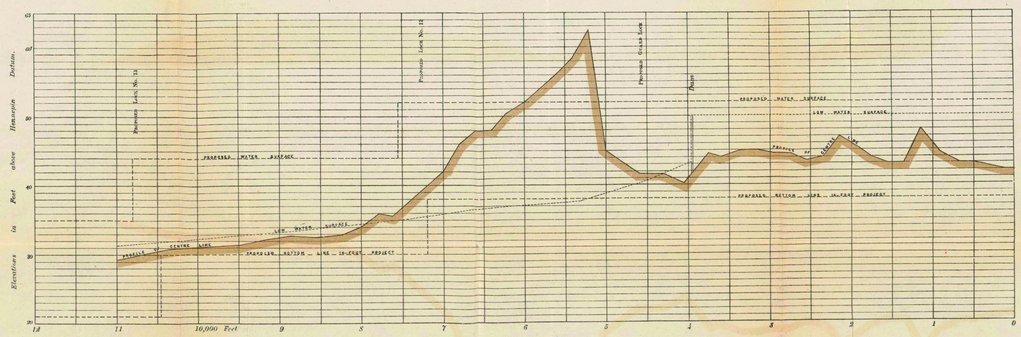
NOTES.

The projection of this Map is based upon chained transit lines referred to True Meridian. Elevations are based upon lines of ordinary levels and are in feet above Hennepin Datum, which is 131.5 feet below Low water of Lake Michigan. (Chicago City Datum.) Elevation of water surface above dam, to which soundings are referred is 50 feet. Elevations in bed of river below dam were taken with stadia.

To accompany my report of this date upon the proposed Waterway between Lake Michigan and Mississippi River
Chicago, Ill., February 28 1890. W. L. Marshall
Captain of Engineers.

Cross Section 100 Feet below Dam.





H Ex L64 pt 2 51 1.

FORBES CO. BOSTON.

MAP

OF

TREATS ISLAND AND VICINITY.

Surveyed in Accordance with an Act of Congress, August 11, 1888,
Under the Direction of

CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS, U. S. A.

BY

L. L. Wheeler, U. S. Assistant Engineer.

1888—1889

Scale for Map: 1 Inch = 300 Feet.

Scales for Profile: { Horizontal, 1 Inch = 750 Feet
Vertical, 1 Inch = 9 Feet.

Feet
Miles.

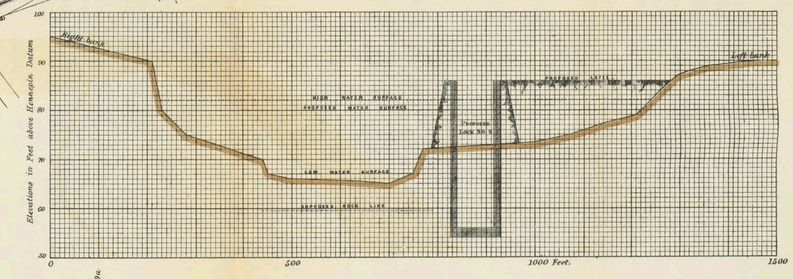
NOTES.

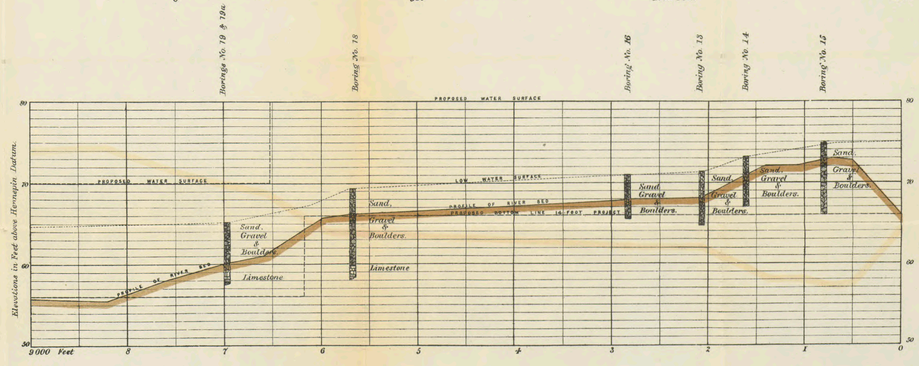
The projection of this Map is based upon chained transit lines referred to True Meridian. Elevations are based upon lines of ordinary levels and are in feet above Hennepin Datum which is 15.13 feet below Low water of Lake Michigan. (Chicago City Datum.) Soundings have been transferred from Map of Survey made in 1883. Borings Nos. 17, 20, 21, & 21 a. are from 3 to 5 feet in gravel and boulders.

To accompany my report of this date upon the proposed Waterway between Lake Michigan and Mississippi River.

Chicago, Ill., February 28, 1890. W. L. Marshall. *Captain of Engineers.*

Cross Section at Site of Proposed Dam.





FORBES CO. BOSTON & N.Y.

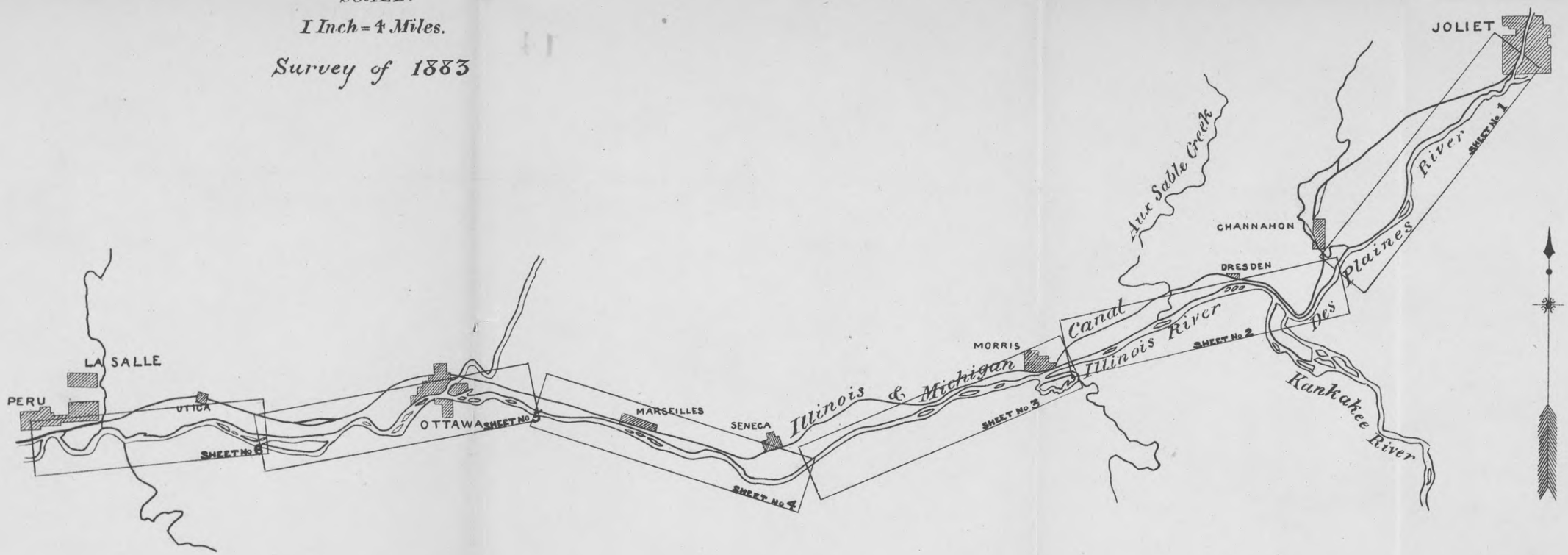
H Ex 264 pt 2 51 1

INDEX MAP.

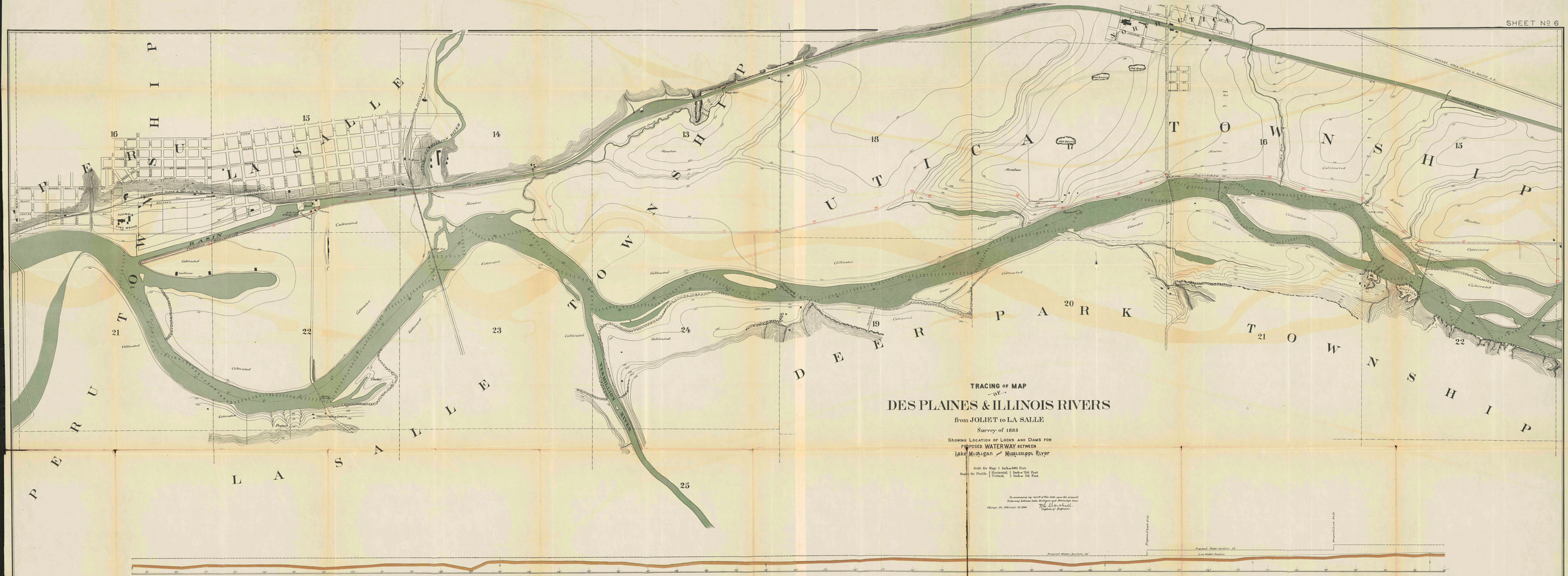
SCALE:

1 Inch = 4 Miles.

Survey of 1883



H Ex 264 pt 2 51 1



TRACING OF MAP

OF

DES PLAINES & ILLINOIS RIVERS

from JOLIET to LA SALLE

Survey of 1883

SHOWING LOCATION OF LOCKS AND DAMS FOR PROPOSED WATERWAY BETWEEN

Lake Michigan and Mississippi River

Scale for Map: 1 Inch=600 Feet.

Scales for Profile: Horizontal, 1 Inch=750 Feet. Vertical, 1 Inch=30 Feet.

To accompany my report of this date upon the proposed Waterway between Lake Michigan and Mississippi River

Chicago, Ill., February 16 1884

Wm. Ludlow,
Captain of Engineers.

FORBES CO. BOSTON

PLATE I

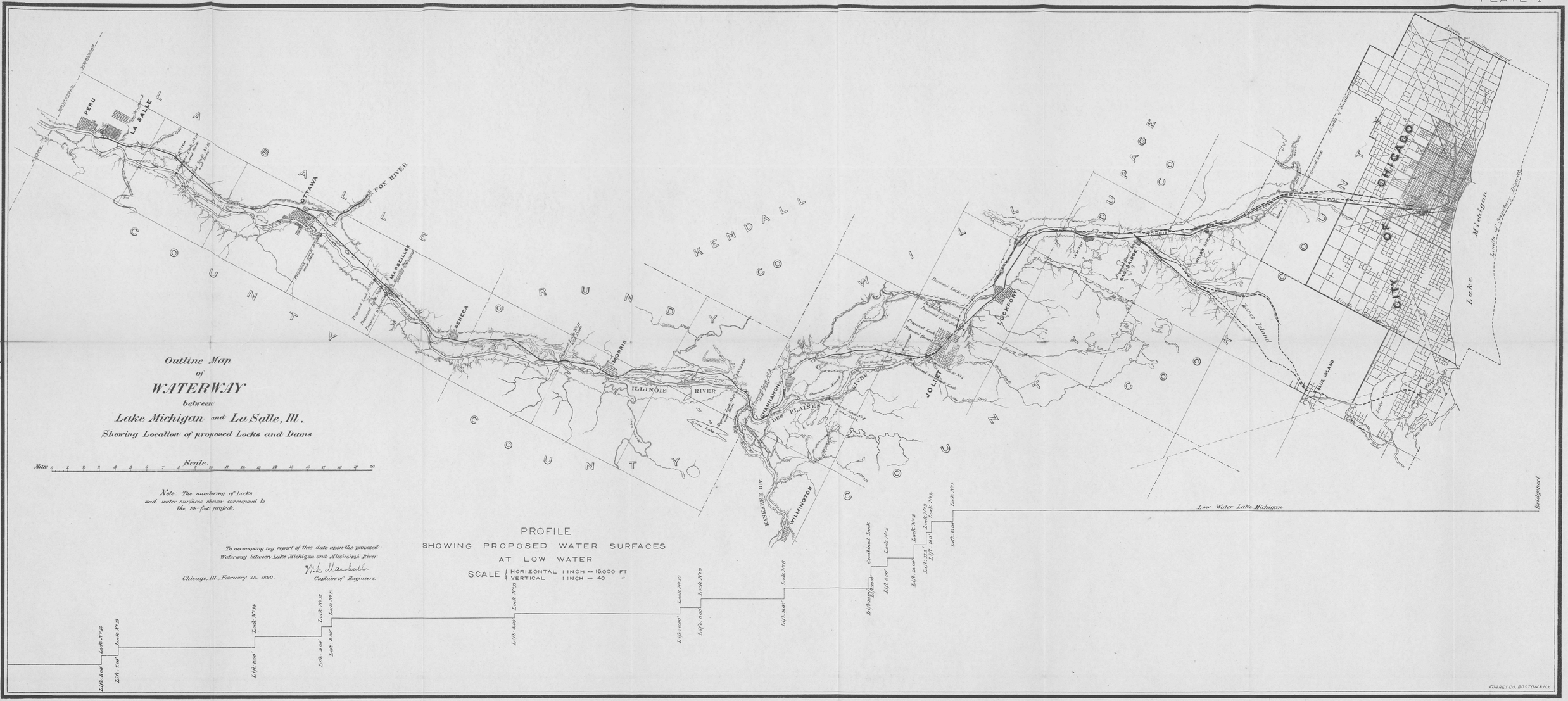

PERU
LA SALLE
OTTAWA
FOX RIVER
MARSEILLES
SENECA
MORRIS
ILLINOIS
RIVER
KANKAKEE RIV.
WILMINGTON
DES PLAINES
CHANNAHON
JOLIET
LOCKPORT
LOCKPORT & ROMEO RAILROAD
Lemont
Willow Springs
Lyons
Riverside
Brookfield
Cicero
Stickney
Forest Park
Berwyn
Oak Park
Maywood
Melrose Park
Bellwood
Hillside
Elmhurst
Addison
Bensenville
Wood Dale
Itasca
Roselle
Schaumburg
Hoffman Estates
Barrington
Palatine
Arlington Heights
Mount Prospect
Des Plaines
Park Ridge
Niles
Evanston
Wilmette
Kenilworth
Winnetka
Glencoe
Highland Park
Lake Forest
Lake Bluff
North Chicago
Waukegan
Zion
Beach
Winthrop Harbor
Kenosha
Racine
Lake Michigan
Lincoln Park
Lake Front Park
Grant Park
Jackson Park
Washington Park
Hyde Park
Woodlawn
Kenwood
Douglas Park
Garfield Park
Humboldt Park
Logan Square
Lincoln Park
Lake View
Rogers Park
Evanston
Calumet River
Chicago River
Des Plaines River
Illinois River
Fox River
Aurora
Naperville
Wheaton
Glen Ellyn
Lombard
Villa Park
Elmhurst
Hinsdale
Downers Grove
Lisle
Woodridge
Darien
Burr Oak Cemetery
Tinley Park
Orland Park
Palos Park
Lemont
Lockport
Joliet
Romeo
Blue Island
Calumet Park
Worth
Palos Hills
Oak Lawn
Evergreen Park
Alsip
Blue Island
Calumet City
Lansing
Thornton
Dixmoor
Harvey
Riverdale
Dolton
South Holland
Homewood
Flossmoor
Chicago Heights
Ford Heights
Steger
Crete
Monee
Peotone
Manhattan
Wilmington
Braidwood
Coal City
Morris
Seneca
Marseilles
Ottawa
La Salle
Peru
Utica
Starved Rock
Buffalo Rock
Plum Island
Goose Island
Calumet Harbor
Chicago Harbor
Navy Pier
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PLATE II

MAP

showing the several routes for that part of the proposed

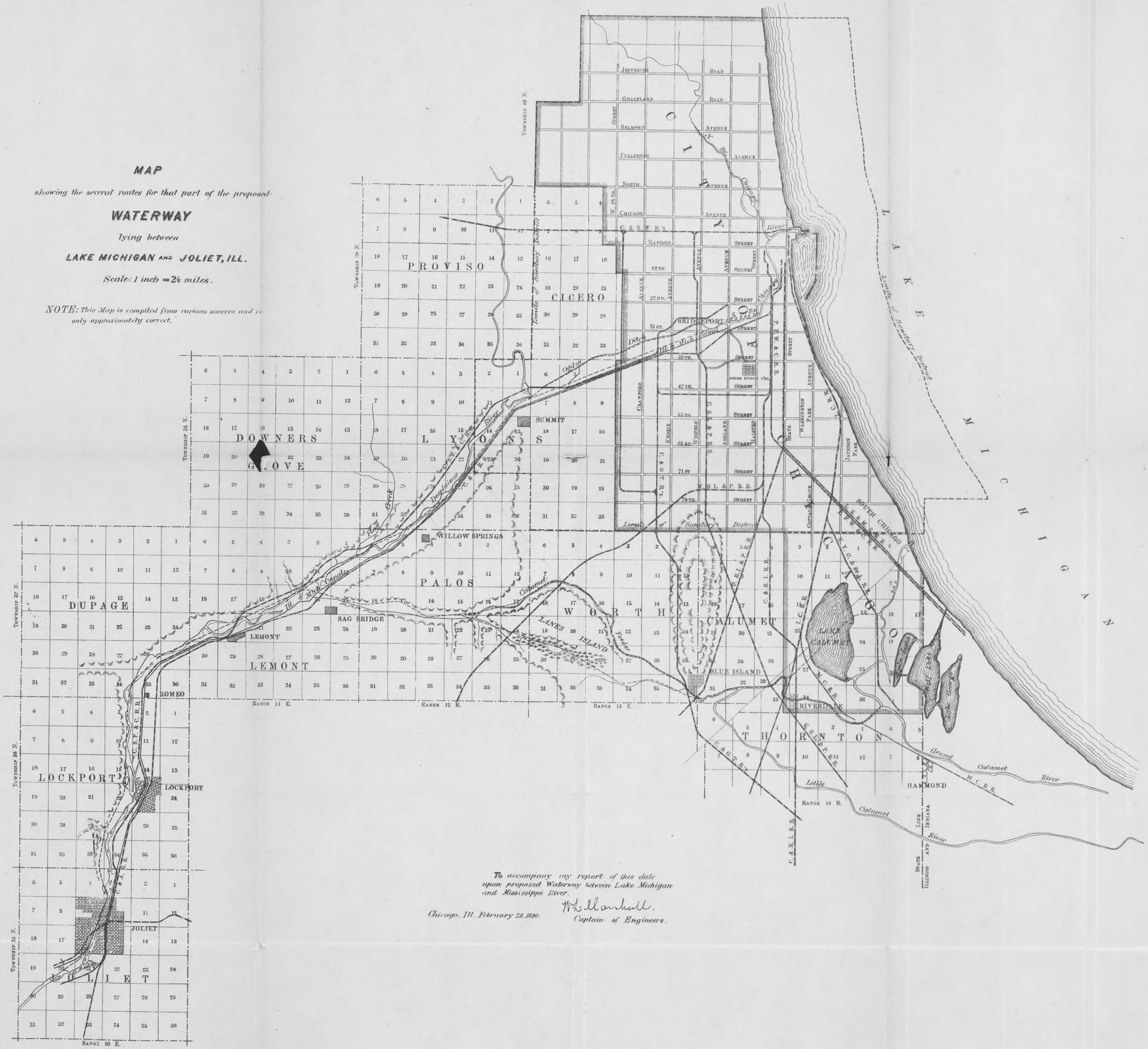
WATERWAY

lying between

LAKE MICHIGAN AND JOLIET, ILL.

Scale: 1 inch = 2¼ miles.

NOTE: This Map is compiled from various sources and is only approximately correct.

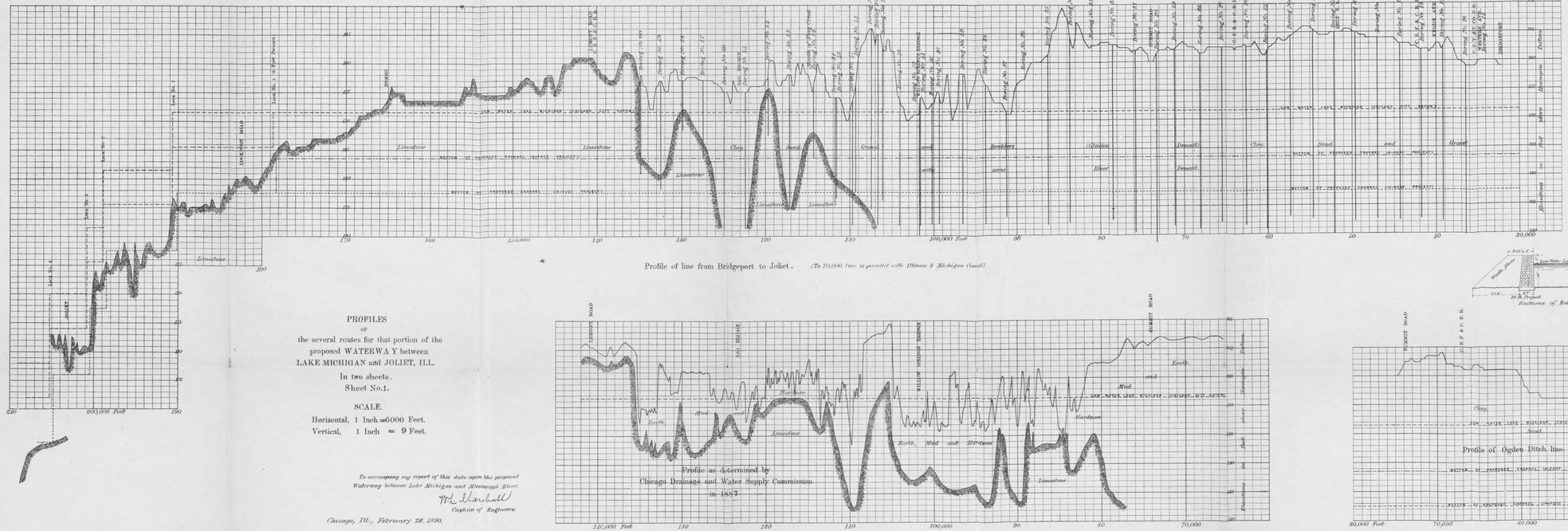


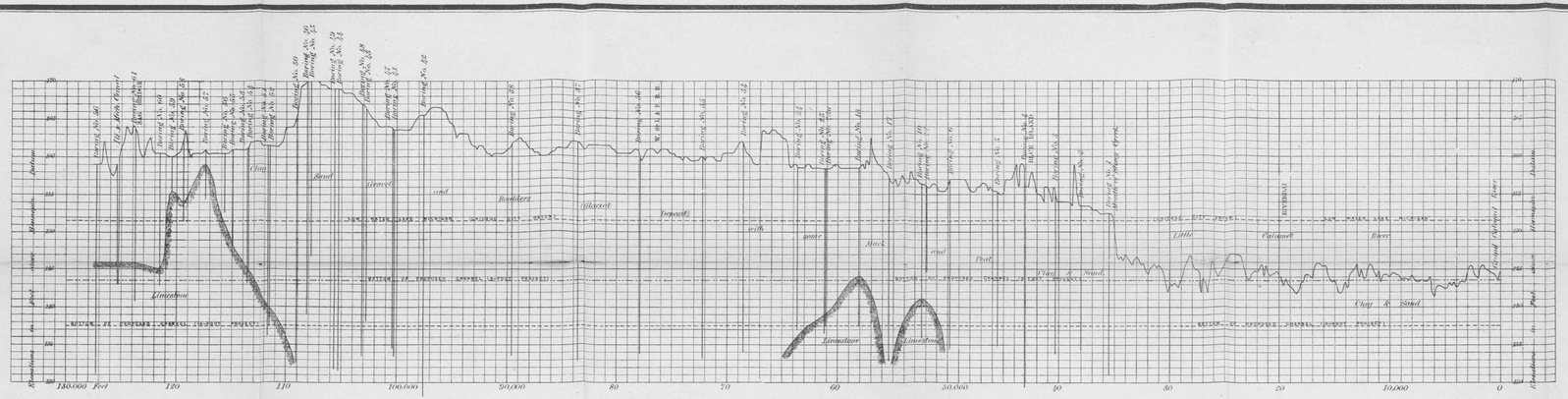
To accompany my report of this date upon proposed Waterway between Lake Michigan and Mississippi River.

Chicago, Ill. February 28. 1890.

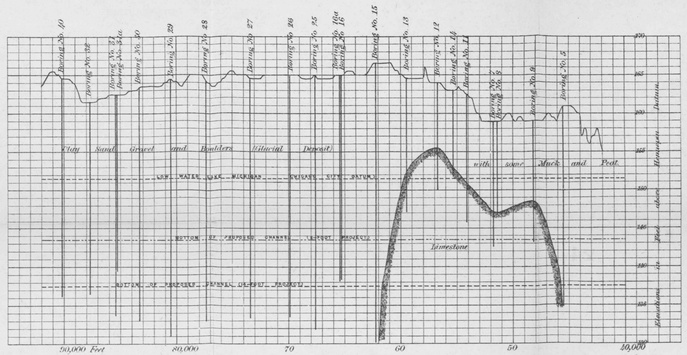
W. L. Marshall.
Captain of Engineers.

Forbes Co. Boston & N.Y.

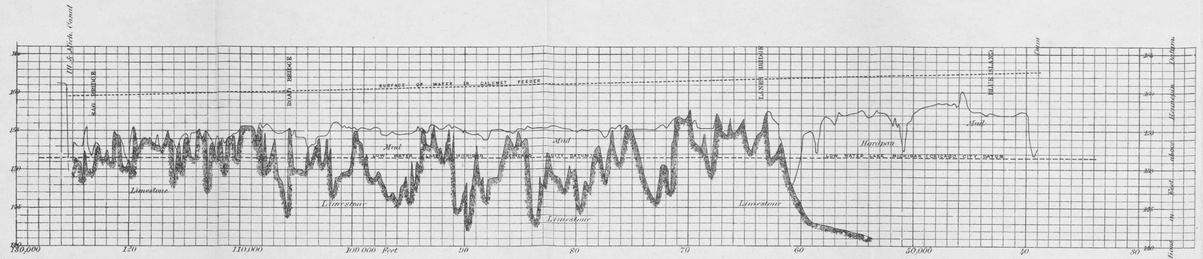

JOLIET
LOCK No. 1
LOCK No. 2
LOCK No. 3
LOCK No. 4
LOCK No. 5
LOCKPORT ROAD
CHICAGO
Limestone
Limestone
Limestone



Profile of line following Little Calumet River and going North of Lanes Island.



Profile of line South of Lanes Island



Profile along Calumet Feeder as determined in 1867

PROFILES
or
the several routes for that portion of the
proposed WATERWAY between
LAKE MICHIGAN and JOLIET, ILL.

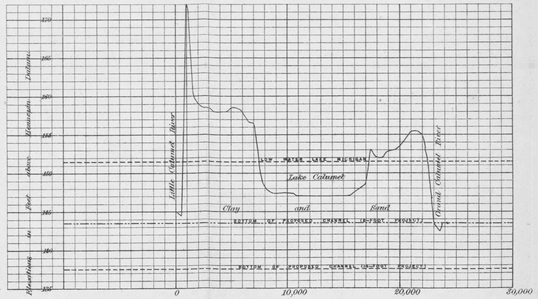
In two sheets.
Sheet No. 2.

SCALE.
Horizontal, 1 Inch = 6000 Feet.
Vertical, 1 Inch = 9 Feet.

To accompany my report of this date upon the proposed Waterway between Lake Michigan and Mississippi River.

H. L. Marshall.
Captain of Engineers.

Chicago, Ill., February 28, 1890.

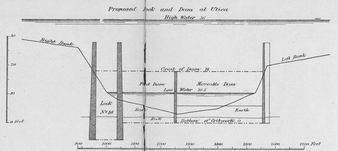


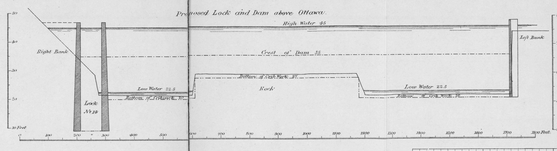
Profile of line through Lake Calumet. *(Joins profile of Little Calumet River at 26,000)*

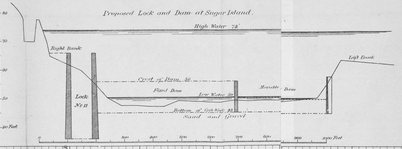
Forbes Co. Boston.

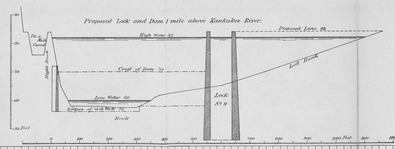
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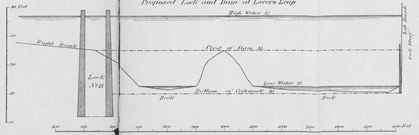
PLATE V

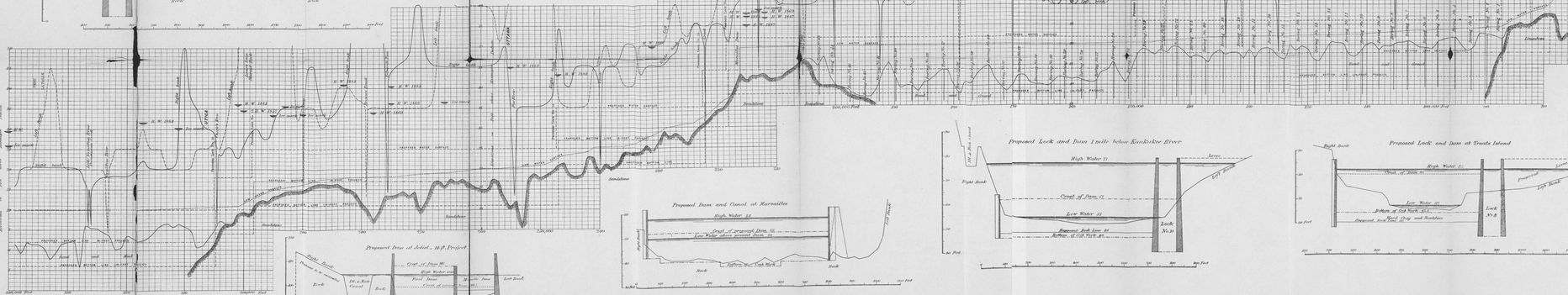


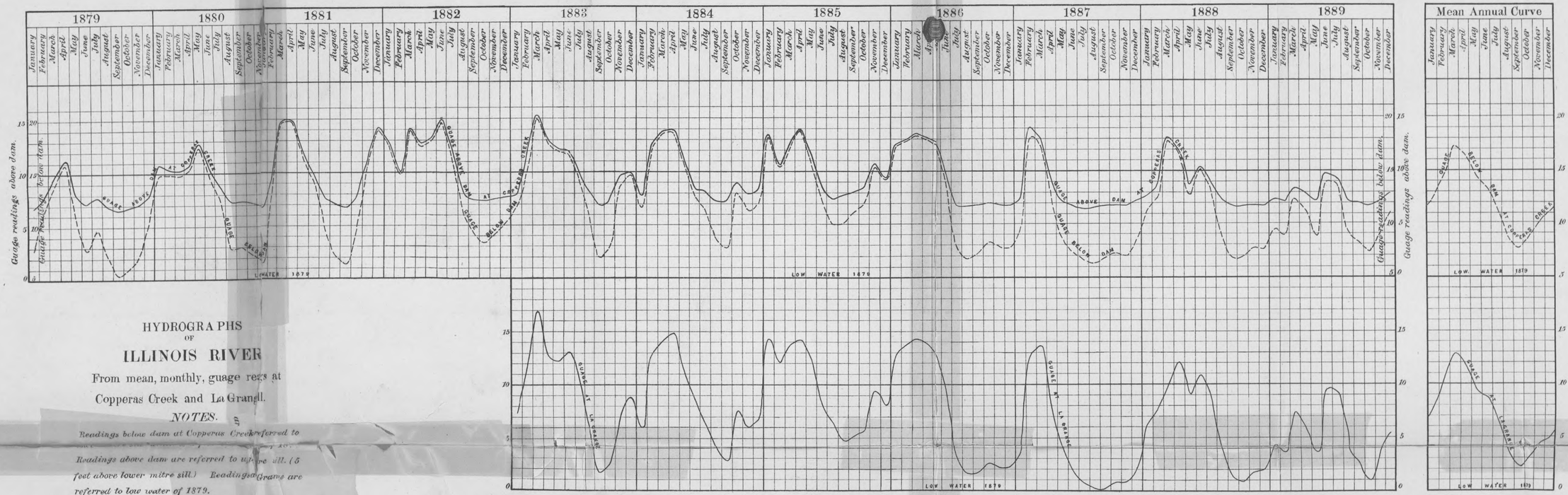









Sandstone
Limestone
Sandstone
Limestone
Sandstone
Limestone



HYDROGRAPHS
OF
ILLINOIS RIVER

From mean, monthly, guage regs at Copperas Creek and La Grange.

NOTES.

Readings below dam at Copperas Creek referred to [illegible]

Readings above dam are referred to upper sill. (5 feet above lower mitre sill.) Readings at La Grange are referred to low water of 1879.

To accompany my report of this date upon the proposed Waterway between Lake Michigan and Mississippi River.

W. E. Marshall
Captain of Engineers

Chicago, Ill., Feburary 28, 18[illegible]

H Ex 264 pt 2 51 1