occupying the Coast Survey stations. A system of small triangles connecting with the Coast Survey points furnished the necessary data for the topography and hydrography of Sheepshead Bay and for the hydrography off Coney Island. Mr. Charles G. Weir had charge of the hydrography, which was executed in the early part of November.

The soundings were taken with poles of 18 and 31 feet length, and were reduced to the plane of mean low-water as established by tidal observations at Coney Island Point and at Tappan's Wharf, in Sheepshead Bay, during one lunation, the day tides being observed. During the soundings off Coney Island the tides were observed near the Brighton Beach Hotel, and the soundings in that vicinity were reduced by these observations.

The survey of Canarsie Bay was made during the months of October and November by the parties under the charge of Messrs. Weir and Meehan; the former executing the triangulation and hydrography, and the latter the shore-line and topography by means of the plane-table.

The execution of the triangulation was very much assisted by information kindly furnished by Captain C. P. Patterson, Superintendent of the United States Coast Survey, giving the geographical positions of the trigonometrical stations in that vicinity. These points were used as ends of base-lines for the establishment of the necessary sounding-stations, and saved the expense of the measurement of a base-line, which, owing to the marshy character of the ground, would have been both difficult and expensive.

The soundings were taken with poles of 18 and 31 feet length, and were reduced to the plane of mean low-water as established by tide-gauges located at the wharf at Canarsie Landing, and at a small wharf on the northeast end of Barren Island, which were observed upon for one lunation of the day tides. The lines of soundings embraced the main or big channel from opposite Canarsie Landing to the north end of Barren Island, and several of the lateral channels, especially that one leading to Canarsie Landing, and the whole of Deep Creek, from Dead Horse Inlet to the bay. The soundings on the flats and from the north end of Barren Island southward, including all outside as far west as Dead Horse Inlet, were reduced from a tracing obtained from the Coast Survey Office of a survey made in 1877. The tide-gauge on Barren Island was connected by a line of levels with a bench-mark on the island established by the United States Coast Survey parties, the elevation of which above the plane of mean low-water was kindly furnished by Captain Patterson. The result of the levels showed an immaterial difference in the planes of reference as established by our observations and those of the Coast Survey party.

The characteristic feature of Canarsie Bay is one large channel of good depth and width, from which numerous branches diverge. These branches divide the bay into islands, and generally lose themselves in the mud flats. The islands and shores are almost entirely salt marsh, bordered by vast mud flats, which were frequently left entirely dry at low-water.

* * * * * * *

Yours, very respectfully,

R. H. TALCOTT,
Assistant Engineer.

Lieut. Col. JOHN NEWTON,
Corps of Engineers, Bvt. Maj. Gen., U. S. A.

APPENDIX E.

ANNUAL REPORT OF COLONEL J. N. MACOMB, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1879.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., August 21, 1879.

GENERAL: In conformity with the requirements of General Orders No. 4, dated Headquarters Corps of Engineers, Washington, D. C., May 21, 1879, I have the honor to transmit herewith my annual reports on the surveys and examinations and the several works of improvement of rivers and harbors intrusted to my care.

In the course of the last fiscal year I have been prevented by sickness from taking that active part which I have been accustomed to in the duties of the field and office. I have also been absent from my station on duty with Boards of Engineers for about two months; but the duties of my station have not suffered from my absence, as they have been most ably performed by my assistant, Capt. William Ludlow, Corps of Engineers, to whom I am indebted for the zeal and intelligence he has displayed in forwarding, in every department, the works in my charge.

All details of information touching the various works are given under the respective heads in the inclosed subordinate reports.

I remain, very respectfully, your most obedient servant,

J. N. MACOMB,
Colonel of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

E 1.

IMPROVEMENT OF SHREWSBURY RIVER, NEW JERSEY.

The improvement of the river was begun with an appropriation of $14,000 in act of March 3, 1871, made pursuant to a report by Lieut. Col. J. D. Kurtz, Corps of Engineers, in October, 1870.

Dredging operations were carried on through the sand shoals near the mouth, and at Rocky and Jumping Points, and continued in 1872. In 1875 a partial survey was made, which showed that the formidable shoals of sand, due to repeated openings in times past through the narrow sea-beach that separates the river from the sea, between Rocky Point and its mouth, could not be sufficiently reduced or controlled by dredging operations alone, and Colonel Kurtz's report of February 1, 1876, indicates the necessity for permanent works to aid in their modification and to secure advantages gained.

The act of June 18, 1878, having appropriated a further sum of $18,000, with the approval of the Chief of Engineers, a thorough survey of the river from the entrance to above Upper Rocky Point on the Nave-

sink, and to above Jumping Point on the South Shrewsbury, was made during the summer of 1878, and a project submitted for the thorough improvement of both branches within the limits indicated. This project was referred to a Board of Engineers, and, with the report of the Board, is appended for incorporation herewith.

It is proposed during the ensuing season, with the balance of previous appropriation, and the appropriation of $10,000 of March 3, 1879, amounting to a total of $26,000, to construct the dikes in the vicinity of Lower Rocky Point, and to dredge the adjacent channels to afford 6 feet at low-water.

During the fiscal year ending June 30, 1881, should appropriation be made, the project could be completed, for which $116,000 would be required. If, however, it should be thought better eventually to improve the flood-channel and thereby avoid any disturbance of the existing draw through the Highlands Bridge, $144,000 would be needed to complete the work.

Shrewsbury River is in the collection-district of Amboy, N. J.

The nearest port of entry is New York. Fort at Sandy Hook is the nearest fort and the Navesink light is the nearest light-house.

The amount of revenue collected at Perth Amboy during the fiscal year ending June 30, 1879, was $9,399.26.

Total amount appropriated to June 30, 1879	$48,500 00
Total amount expended to June 30, 1879	22,815 58
Total estimated cost of existing project approved February 12, 1879	142,086 00

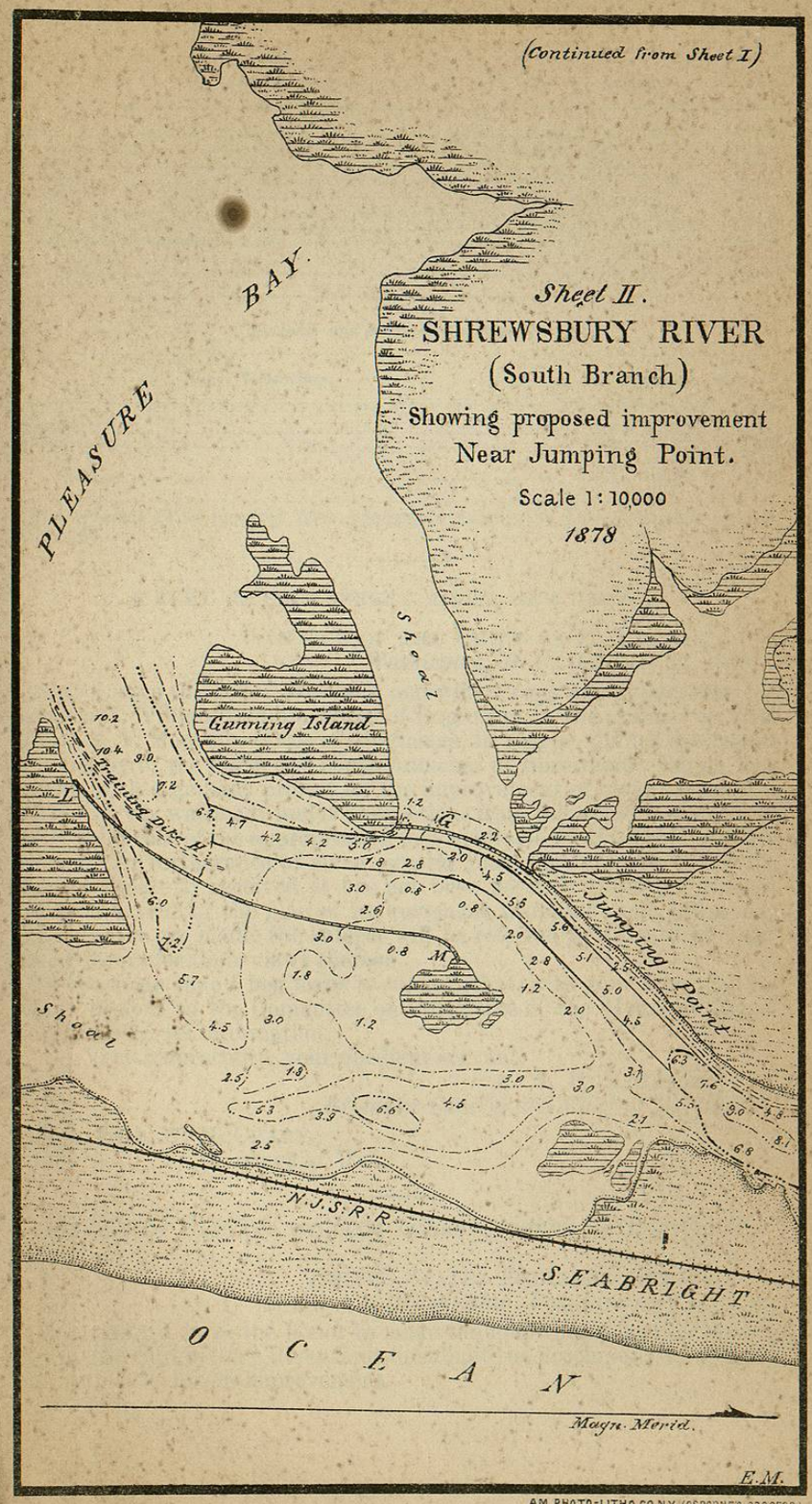
Money statement.

July 1, 1878, amount available	$18,000 00	
Amount appropriated by act approved March 3, 1879	10,000 00	
		$28,000 00
July 1, 1879, amount expended during fiscal year		2,315 58
July 1, 1879, amount available		25,684 42
Amount (estimated) required for completion of existing project		116,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1881		116,000 00

Commercial statistics of Shrewsbury River.

IMPORTS.

Articles imported.	Quantity.	Value.
Oysters ..... bushels	20,000	$5,000
Peaches ..... baskets	1,500	1,125
Hardware		55,000
Lumber ..... feet b. m.	4,712,500	133,000
Lime ..... barrels	1,650	1,650
Cement ..... do	1,400	1,850
Plaster ..... do	600	660
Shingles	325,000	5,400
Limestone ..... tons	75	1,780
Guano ..... do	43,752	5,350
Coal		131,434
Phosphates		300
Bricks	2,900,000	15,000
Agricultural lime ..... bushels	4,000	1,200
Gas lime ..... do	9,000	360
Shell lime ..... do	4,800	480
Manure		2,130
Sawdust ..... Barrels	1,200	600
Laths	1,500,000	3,000
Glass		5,000
Paint		2,000
Ice ..... tons	1,100	5,500
Miscellaneous merchandise		131,000
Total		508,819



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EXPORTS.

Articles exported.		Quantity.	Value.
Straw	tons	130	$1,820
Hay	do	240	3,840
Fruits			140,090
Potatoes	barrels	57,700	86,250
Garden truck			77,636
Clams	barrels	800	2,000
Oysters	bushels	10,000	15,000
Miscellaneous merchandise			25,000
Total			351,636

Arrivals and departures of vessels.

What class.	No.	Tonnage.	Crews.
Steamers	575	520,311	10,088
Sailing-vessels	426	218,261	1,704
Total	1,001	738,572	11,792

The steamer fares received from passengers during the past year amounted to $17,824.50.

SURVEY OF SHREWSBURY RIVER, NEW JERSEY.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., January 22, 1879.

SIR: I have the honor to submit herewith a copy of a report received from Capt. William Ludlow, Corps of Engineers, in the absence on duty of Col. J. N. Macomb, Corps of Engineers, in charge, giving the results of a survey of the north and south branches of Shrewsbury River, New Jersey, with a general project for the improvement of their navigation.

This survey was made under instructions from this office, in order that the expenditure of the appropriation now available for this locality might be made in furtherance of some general plan, and, the report having been but recently received, it has not been possible to reach a decision upon the merits of the plan of improvement proposed; but, before any expenditures are made, the subject will be referred to a Board of Engineer Officers for their views thereon.

In the mean time I beg leave to suggest that, with your approval, the report be sent to the Committee on Commerce of the House of Representatives for its information.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.

Hon. GEO. W. MCCRARY,
Secretary of War.

REPORT OF CAPTAIN WILLIAM LUDLOW, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., January 11, 1879.

COLONEL: I have the honor to make the following report on the survey of the Shrewsbury River, and to submit the accompanying projects and estimates for its improvement.

The survey was made between August 21 and September 17, 1878, as follows:

Three tide-gauges were established and signals erected at suitable points; a transit-line was run and twice carefully chained along the front beach from near the cove to above Seabright, a distance of nearly 4½ miles.

The hydrography, which required parts of seven days, was executed in a small steam-launch by means of two sextants. Much loss of time was occasioned by the necessity for waiting until the tide had risen sufficiently to enable the launch, which drew but 2 feet, to cross the shoals.

Current-observations were made at the several points indicated on the chart, surface velocities only being taken, owing to the small and varying depths.

The work of the survey is tabulated on an appended sheet.

The Shrewsbury, including under this title the main stem and both branches, is essentially a tidal basin, filled and emptied by the daily movements of the water of Raritan Bay. The south branch is a broad, shallow expanse of irregular outline, occupying a mean area of about 4 square miles, with flat and marshy shores. It receives a small proportion of the rain-fall of an area of about 40 square miles of sandy and permeable soil, and discharges northwardly into the main stream near Rocky Point through a narrow and much obstructed neck about 2 miles long and 375 feet wide at the narrowest place.

The area occupied by the north branch or Navesink is about 5 miles by a half mile, or 2½ square miles, bounded by bold and picturesque shores. It drains a tract covering some 80 square miles of lands much higher and more compact than those tributary to the other branch, and has a certain fresh-water supply, which is, however, unimportant relatively to that derived from the tides. Previous to effecting a junction with the South Shrewsbury its water-way is contracted to 1,000 feet at Upper Rocky Point and again to the same width at Lower Rocky Point, 3,500 feet farther down.

Here the two branches unite nearly at right angles, and flow north past the Highlands in a stream about 1,200 feet in width, separated from the ocean by a low sand-beach from 200 to 400 feet wide.

At Paradise Point, 7,200 feet below the junction and the same distance above the bar, the width increases from the northwestwardly trend of the west shore and an island separates the river into two channels. The triangular-shaped area intervening before the bar is reached is choked with sand deposits, through which the two channels push their way with greatly diminished depth and force. Measured along the bar, which lies nearly at right angles to the general movement of the water and forms the base of the triangle, the width is over a mile, and beyond are the deeper navigable waters of Sandy Hook Bay.

The tidal observations are given on an appended sheet. At the first gauge on the west shore near the bar the average observed rise was 5 feet. At Riker's Wharf, 10,000 feet farther up, it diminished to 3 feet, and at the Seabright Bridge across South Shrewsbury, 8,400 feet farther, it was 1.3 feet only. This rapid diminution of the rise and fall is noted in connection with the intervals between the high-water at the several gauges, which show that the tidal wave ascends with a velocity less than 2½ miles per hour.

The current observations show that the velocities vary at different points from 0.58 mile to 1.78 miles per hour. Assuming these to be the maximum velocities, those of the water in contact with the bed would be approximately between 0.35 mile and 1.07 miles per hour. The lower

figure is that at which fine sand, such as is the main, and in fact almost the sole constituent of the river bed, is kept in motion, while the higher velocity would move a coarse gravel. It follows that with each ebb and flow there is a daily oscillation of the bars up and down the stream, but as the ebb-tide in the main stem and north branch preponderates somewhat both in duration and velocity, the resultant movement is slowly downward.

The general condition of the river and a summary of its previous history, so far as relates to the successive opening and closing of inlets through the beach at various points and times, are given in a report by Col. J. D. Kurtz, dated February 1, 1876 (p. 278, Annual Report Chief of Engineers, 1876). An account is also given therein of the works of improvement carried on up to that time. These consisted, during 1871–'72 and '73, of dredging over the shoals which most interfered with navigation; special attention being given to those at Upper and Lower Rocky Points and below and west of Island Beach, the small amounts available at any one time not admitting of the construction of any permanent works.

In consequence, the advantages gained were not found sufficient, and Colonel Kurtz, after making a partial survey in 1875, recommended the construction of a deflecting dike opposite Lower Rocky Point, supplemented by dredging in that vicinity and above. A considerable interval having elapsed since his examination was made, during which the river has assumed a comparatively stable regimen from the continued maintenance of the front beach, it was thought advisable that an accurate determination of the existing features and condition of the river should precede any project for the application of the current appropriation, viz, that made in river and harbor act of June 18, 1878, of $18,000.

The obstructions to navigation now existing are as follows:

1st. At the bar; the re-entering 6-foot curve from the bay incloses the buoy marking the entrance. Thence at or near high-water 5½ feet can be carried straight on west to the Island Beach, and thence upward; at lower stages of the tide, vessels drawing over 4 feet, after rounding the bar buoy, must turn sharply eastward, passing over a shoal with but 3½ feet at mean low-water, and thereafter follow a curved channel which gradually deepens to 10 feet.

2d. After passing Island Beach the channel again shoals to a little over 4 feet in crossing to the draw, and much difficulty is here experienced. Above the bridge the channel depths are 10 and 12 feet until

3d. Near Rocky Point, where the channel divides, one branch passing close around the point and gaining deeper water just beyond, but obstructed by a shoal of from 3½ to 4½ feet. The other channel describes a broader sweep, and having a least depth of 4.3 feet is the one navigated.

4th. Near Upper Rock Point the two channels, which have been separated by a large sand-bar, nearly unite, but divide again at once, the southernmost 6-foot curve leading directly to the path of vessels near Oceanic Wharf, above which the course is free toRed Bank, the head of navigation.

5th. By the weightier flow out of the Navesink, the outlet of the South Shrewsbury is crowded close under the beach, and its downward course is obstructed by a great accumulation of sand lying directly in its path. This deposit is noted in Colonel Kurtz's report of 1876, and referred to a breach in that locality previous to 1844. It has for many years been slowly spreading, and, in combination with the sudden changes in direction and the conflicting currents at Rocky Point, gives rise to much of

the shoals in this vicinity. At high-water 4½ and 5 feet can be taken through a crooked channel to the Bellevue Dock, above which is a narrow, low-water channel 5 and 6 feet as far as Jumping Point;

6th. Where, for a distance of 3,000 feet, the 6-foot curve is interrupted, and an available depth of between 2 and 3 feet only found. Above Gunning Island, the navigation of Pleasure Bay is understood to be measurably unobstructed, and no complaints have been received of any lack of suitable facilities. The opening of the channel below would considerably increase the rise of tide, and any further needed relief would be gained by dredging.

The following project is proposed for the general improvement of both branches:

I. THE SOUTH SHREWSBURY.

1. Beginning at Jumping Point, to open a channel 6 feet deep and 150 feet wide between the 6-foot curve above and below, and to close the opening between the Point and Gunning Island by a dike (marked G on the chart), for the purpose of preventing interference with the dredged channel. It may further be found necessary for the maintenance of this channel to construct the training-dike, H, but it is not included in the present project. The projection above the bridge of the east-shore line, which narrows the width to 375 feet, is a serious obstruction, and should be removed if a thorough improvement of the river is undertaken.

2. Below the Seabright Bridge, to dredge a 6-foot channel 200 feet wide, and to construct the dikes F and E to cut off the interchange, which, to a considerable degree, takes place through these cuts and over the site of D. (The projection from the east shore in this vicinity, due to a previous irruption of the sea, should at some future time be removed.)

3. From opposite E to the mouth, to dredge the channel, following the lines drawn on the chart, and to build dike D, for the purpose of guiding the flow and protecting it against the outpour from the shoal area to the westward and against the ebb-tide of the Navesink.

4. To secure a freer admission of the flood-tide, by the removal of the shoal area marked O.

II. THE NAVESINK.

1. Beginning above Barley Point to dredge a 200-feet channel 6 feet deep past the point, thence gradually widening it to 300 feet to the 8 foot curve below, and to construct the dike C_2, for the purpose of guiding the ebb and intercepting its passage into the shoal area.

2. To remove the shoal marked P between the channel lines as laid down on the chart, and to construct the dike C, of the form and position indicated. This dike will deflect the ebb-tide so as to enable it to effect an easy junction with that of the south branch, and will confine the flood to the channel. It unites with D, and both abut against a triangular crib filled with stone, having faces of 60 feet, and its down-stream edge and upper face ironed against ice.

THE MAIN STEM.

Two projects offer themselves for the improvement between the bridge and the bar; one involves the improvement of the flood-channel direct from the entrance to the draw; the other provides for following the ebb-channel under the front beach and finding an exit nearer Cove Point. The details are as follows:

III. IMPROVEMENT OF THE WEST OR FLOOD CHANNEL.

1. To remove the shaded areas below the bridge, the uppermost one to 8 feet, the others to 6 feet, and thence dredge a 6-foot channel 300 feet wide straight to the entrance.

2. To construct the training-dike A to intercept the ebb, and control its tendency to cross to the east channel.

This dike lies nearly parallel to the flow of the flood-tide, and would interpose no obstruction to its free entrance. An opening is left between the upper end and the bridge for the convenience of small vessels.

The 8-foot area near the draw is removed for the purpose of giving the channel its initial direction.

IV. IMPROVEMENT OF THE EAST OR EBB CHANNEL.

1. To construct a new draw in the position indicated, with its pier and training walls parallel to the current. This either at the expense of the appropriation or of the bridge company, if it can be required to make the alteration.

2. To dredge a channel 6 feet by 300 feet to the bar, as indicated, and to construct a training dike, B, connecting with the beach at Crane Point, and thence continuing across the bar. This dike is required to prevent the ebb tide from following the beach into the cove, whence it flows close around Cove Point. Its strength and scouring action are hence greatly impaired, and unless controlled and concentrated could not maintain a channel.

3. To dredge the shaded area above and below the bridge to 6 feet.

4. To protect the inner beach by sheet piling as far as may be necessary.

Of these two projects the first cost of the latter, V, is the less, even including the removal of the draw. It accommodates itself also to the natural course of the ebb tide, and takes advantage of the sheltered basin under Island Beach. On the other hand, it is greatly exposed to an irruption from the sea, which would immediately destroy it, and if its strength were materially increased it would be necessary to protect the bank from Crane Point to the bridge, and to co-operate with the railroad company in the necessary measures to maintain the outer beach. There would probably always be a certain amount of shoaling on the bar during the flood tide and the prevalence of north and northwest winds. As the flood tide crossing the bar at all points will not follow this channel, but will probably always pour its main volume to the westward of Island Beach, some shoaling may hereafter be found as at present, though in less amount, between Island Beach and the bridge.

The alternative project, IV, requires heavy cutting in shoal water, and it is likely that more or less filling would take place for some time about midway between Island Beach and the bar, from the accumulations on either side. It possesses a great advantage in terminating in naturally deep water above, and in utilizing the natural entrance, which has remained for many years nearly unchanged in position and character. The ebb tide deflected by dike A would push the deep water nearly as far downward as it now does in the east channel, and thereby greatly limit the distance over which shoaling would be probable.

Omitting the consideration of original cost, it is believed that the best results will in the long run be attained by the improvement of the flood channel.

It is to be remarked, also, that while the construction of dike B is re-