New London; a light-house is situated at the entrance on the west shore. As shown by the statistics submitted in last year's report, the amount of commerce to be benefited by the improvement of this river is very large, some of the items being as follows: 100,000 tons coal, 2,000,000 to 4,000,000 feet lumber, 2,000,000 brick; besides, large quantities of sugar, molasses, and other merchandise. It is estimated that 90 per cent. of the duties collected in the district are paid by Norwich merchants.

The following statistics have been received through the courtesy of Mr. J. A. Tibbitts, collector of customs at New London, for the fiscal year ending June 30, 1879:

Collections:	
Duties on imports	$52,229 15
Tonnage dues	483 90
Hospital tax	1,945 81
Miscellaneous receipts	4,636 55
	59,295 41
Number of foreign vessels arrived from foreign ports	11
Number of foreign vessels cleared for foreign ports	8
Number of American vessels arrived from foreign ports	16
Number of American vessels cleared for foreign ports	6
Total number of vessels of all classes entered and cleared during the fiscal year ending June 30, 1879	85
Total tonnage of the district, 204 vessels: tons	21,578.46
Estimated value of cargoes received	$175,523
Estimated value of cargoes exported	$41,619

Draught of vessels not known.

Number of vessels of all classes entering the harbor for refuge during the year not known.

HISTORY OF THE IMPROVEMENT TO 1879.

The Thames River is formed by the junction of the Shetucket and Quinnebaug Rivers, in the eastern part of the State, and, taking a southerly course for 16 miles, empties into Long Island Sound. At the head of the river is the city of Norwich, the third in wealth and fourth in population in the State of Connecticut.

In 1870, the population of Norwich was 16,653 inhabitants. It is the terminus of the Norwich and Worcester Railroad; is on the line of New London Northern (Vermont Central) Railroad, and has a daily and weekly line of steamers to New York.

That portion of the river within 4 miles of Norwich is that upon which improvements have been attempted. The mouth of the river is known as New London Harbor, and 5 miles above the mouth is the New London navy-yard. The mean rise and fall of the tide at Norwich is 3.1 feet.

By act of Congress of March 3, 1821, $150 was appropriated "for the purpose of enabling the Secretary of the Navy to remove obstructions placed in the river Thames, in Connecticut, by the commander of American ships during the late war." What these obstructions were and when removed the records fail to show. By the act of Congress approved March 2, 1829, $150 was appropriated "for making a survey of the river Thames, with a view to improve the navigation of the same and the cost of such improvements."

In a report to General Gratiot, Chief Engineer, under date of February 20, 1830, Capt. Hartman Bache, Topographical Engineers, says that—

> Various attempts have been made to improve the navigation of the river Thames at different periods since 1785. These, till within a few years (1830), were confined to actual excavations of the most approved channels. Efforts thus directed to the removal of the deposits, rather than of the constantly operating causes by which they are produced, afforded, as might have been expected, only a temporary relief from the evils of so limited a navigation, and that in proportion to the means employed. Latterly, in conjunction with dredging, permanent means by piers have been resorted to.

Estimates were submitted for improving the river by dredging and the building of additional piers at an expense of $72,650; 43,436 cubic yards of stone to be used in the piers, and 69,251 cubic yards of material to be excavated to make the channel 100 feet wide and 14 feet deep at high-water.

It would seem from the records that a "bonus" to be used in improving the river was given in 1825 by the Merchants' Bank of Norwich, probably for the privilege of exacting tolls from vessels going up the river. The amount of the "bonus" is not named; but in 1835 $1,626, and in 1836 $2,053 was expended in dredging. The average cost per cubic yard for material removed was 10⅕ cents in 1835 and 12⅘ cents in 1836.

By act of Congress of July 4, 1836, $10,000 was appropriated "for deepening the channel of the river Thames leading into Norwich Harbor." By act of Congress approved March 3, 1837, $20,000 was appropriated for continuing the improvement.

By act of Congress of July 7, 1838, $10,000 was appropriated for continuing the improvement; this money was expended in building jetties and in dredging according to the plans of Major Bache.

By act of Congress of June 23, 1866, $10,000 was appropriated "for improvement of Thames River, Conn." In July the work was placed in charge of Maj. D. C. Houston, Corps of Engineers, and during the fall of 1868 a survey of the river in the vicinity of Norwich was made by J. A. Judson, civil engineer.

By act of Congress of March 2, 1867, making appropriations for the repair, preservation, and completion of certain Public Works, &c., $36,000 was appropriated for the improvement of Thames River, Conn., and by an act of Congress approved March 2, 1867, making appropriations to supply deficiencies in the appropriations for the service of the government, &c., $36,000 was appropriated "for dredging and maintaining the channel of the river Thames near Norwich, in the State of Connecticut, to complete the work."

Proposals were invited by Major Houston in April, 1867, for dredging about 80,000 cubic yards of material to obtain a channel of 14 feet depth at high-water. The contract was awarded to Mr. E. A. Bill, of Norwich, Conn., at the rate of 45 cents per cubic yard. Work was prosecuted during the season of 1867, '68, and '69, during which time 159,398 cubic yards of material were removed, making a channel 100 feet wide and 11 feet deep at mean low-water from Indian Point to the docks at Norwich. At Norwich, opposite the Norwich and Worcester Railroad Docks, the channel was made 200 feet wide. By act of Congress approved March 3, 1871, $15,000 was appropriated for the improvement of the river. A contract for dredging was made with Mr. E. R. Seward, of Albany, N. Y., at the rate of 20 cents per cubic yard. During the summer of 1872 56,521 cubic yards of material were removed, making the channel 100 feet wide and 11 feet deep at mean low-water from Cooper's Point to the Rolling Mill Wharf.

By act of Congress of June 10, 1872, $10,000 was appropriated for the further improvement of the river. A contract for dredging was made with Mr. E. R. Seward, of Albany, N. Y., at the rate of 19 cents per cubic yard. During the fall of 1872 and spring and summer of 1873, 50,189 cubic yards of material were removed, making the channel at least 100 feet wide from Rolling Mill Wharf to the Norwich and Worcester Railroad Wharf and opposite the latter 200 feet wide and 11 feet deep at mean low-water. During the prosecution of this work Mr. H. A. Bentley, civil engineer, made a survey of the river from Norwich to Cooper's Point, a distance of about 3 miles.

In February, 1877, Major J. W. Barlow, Corps of Engineers, upon the representation of the citizens of Norwich, and after a personal examination of the river, recommended that a further appropriation be made to remove shoals that had formed since 1873.

By act of Congress of June 18, 1878, $10,000 was appropriated for the further improvement of this river.

The following is a condensed history of the work done upon the Thames River:

Date of appropriation.	Amount.	How supplied.
March 3, 1821	$150	Removing obstructions placed in the river during the war of 1812.
March 2, 1829	150	Survey.
July 4, 1836	10,000	Building piers and dredging.
March 3, 1837	20,000	Do.
July 7, 1838	10,000	Do.
June 23, 1866	10,000	Dredging and survey.
March 3, 1867	72,000	Dredging.
March 3, 1871	15,000	Do.
June 10, 1872	10,000	Do.
June 18, 1878	10,000	Do.
March 3, 1879	12,000	

Money statement.

July 1, 1878, amount available	$10,000 00	
Amount appropriated by act approved March 3, 1879	12,000 00	
		$22,000 00
July 1, 1879, amount expended during fiscal year		9,589 63
July 1, 1879, amount available		12,410 37
Amount (estimated) required for completion of existing project		164,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1881		75,000 00

C 3.

IMPROVEMENT OF NEW HAVEN HARBOR, CONNECTICUT.

Under the appropriation of $25,000 made by act of Congress approved June 18, 1878, bids for dredging between Long Wharf and Fort Hale were solicited, with a view of widening the main ship-channel and deepening the same to 16 feet at mean low-water; the length of the excavation to be about 3,500 feet. Proposals were opened on the 6th of August.

Following is an abstract of bids received:

Name.	Address.	Price per cubic yard.	To commence—	To complete—	Remarks.
Morris & Cumings Dredging Company.	New York	0.08¾	Aug. 15, 1878	June 30, 1879	Guarantee not certified.
John M. Seward	Albany, N. Y.	0.11	Aug. 15, 1878	June 30, 1879	
Henry D. Dennison	Syracuse, N. Y.	0.11	Aug. 15, 1878	June 30, 1879	
George C. Fobes & Co.	Baltimore, Md.	0.11	No date.	July 1, 1879	Guarantee not certified.
H. N. & A. J. Beardsley	Bridgeport, Conn	0.11½	Aug. 15, 1878	June 30, 1879	
S. A. Hammond	do	0.12	Aug. 15, 1878	June 30, 1879	
Morris F. Brainard	Albany, N. Y.	0.12¼	Oct. 1, 1878	June 30, 1879	
Atlantic Dredging Company		0.15	Oct. 15, 1878	June 30, 1879	

The contract was awarded to the Morris & Cumings Dredging Company, New York City, at 8¾ cents per cubic yard, that firm being the

lowest bidder. The specifications required the material to be deposited in deep water east-southeast of Round Rock Reef, at a distance of about 5 miles from the work. The appliances furnished were all of first-class quality, the dredge being capable of removing 500 cubic yards per hour. Two powerful steam-tugs were constantly employed in towing the excavated material in scows of 500 cubic yards capacity.

The work was commenced on the 12th of August, and during that month 62,159 cubic yards of material were removed. The excavation was made in two cuts, extending from a point opposite Long Wharf to the 16-foot curve near buoy No. 5, a distance of 3,500 feet below Long Wharf. Similar progress was made during the months of September and October and to the 21st of November, when, the full amount of 250,000 cubic yards required by the contract having been removed, the work was discontinued.

As the result of the season's operations, a channel 16 feet deep at mean low-water, and nearly 300 feet wide throughout a length of 3,500 feet, has been excavated, where the former depth was from 10 to 15 feet. The material removed was mostly a black or bluish mud, in some instances mixed with cinders and oyster shells in considerable quantities. These are accounted for upon the belief that steamers frequently dump the refuse of their furnaces into the channel, and that oystermen on their passage up from the oyster grounds are accustomed to cull their oysters, throwing overboard the worthless portions of their cargoes. Large quantities of shells are often thrown into the harbor below Fort Hale, for the purpose of propagating oysters. These causes undoubtedly tend to the filling up of the channel.

THE NECESSITY FOR A FURTHER ENLARGEMENT OF THE CHANNEL.

The depth of 16 feet given to last season's work is believed to be no more than the immediate necessities of the commerce of this harbor demand, to avoid interruptions and delays in the movement of vessels to and from the wharves.

During the last season's work the inspector in charge was directed to notice, when practicable, and report the draught of freighting-vessels arriving with cargoes at the upper wharves.

From his observations it was shown that a number of sailing-vessels of 700 to 750 tons, drawing 13½ to 14 feet, are in constant communication with the docks above Long Wharf. These vessels are freighted principally with coal and lumber, while several steamers, drawing 16 to 18 feet loaded, are engaged in the same trade.

Twenty-three vessels from the West Indies, drawing 14 feet, discharge at Long Wharf.

It is stated that a good prospect at one time existed for a direct steamship line with Liverpool, which would have been an accomplished fact had the owners found a sufficient depth to carry vessels of 20 or 21 feet draught to the wharves at high-water. It would seem, therefore, highly judicious that the project of enlarging the main channel so as to obtain a continuous depth of 16 feet to the city wharves, with sufficient width to permit the easy and safe passage of vessels of 14 and 15 feet draught at all stages of the tide, and steamers of 20 or 21 feet draught at high-water, should be carried into effect at the earliest practicable moment.

Viewing the subject in this light, I presented, on the 4th of February, 1879, after making an examination of the harbor, in connection with the season's work, the following letter:

ENGINEER OFFICE, U. S. ARMY,
New London, Conn., February 4, 1879.

GENERAL: I have respectfully to transmit by to-day's mail a tracing showing the results of an examination of New Haven Harbor, made in December, 1878, upon the conclusion of the season's dredging under the act of Congress making appropriations for the fiscal year ending June 30, 1879. Besides sounding the area dredged this season, the examination was extended north to Tomlinson Bridge and south to include the bar below Fort Hale; owing to rough weather, the latter area was not as thoroughly examined as was anticipated, though a sufficient number of soundings were obtained to give a close approximation to the present depth.

Between Long Wharf and Belle Dock the channel has been dredged at different periods to an aggregate width of 400 feet, the depth gained being 13 feet; and since no part of this area has been deepened a second time, it is seen that the depth has remained nearly permanent.

Shoaling to the extent of 1 foot is noticed in some places, due probably to washing in of the east bank and to sewerage deposit from the city. The bend opposite Long Wharf appears to have made out considerably, and should be well cut away when dredging shall be resumed in this part of the harbor.

Below Long Wharf the depth this season was made 16 feet, as it was represented that the previous depth of 13 feet would not permit a large class of vessels plying to this port to reach the docks except at extreme high tide, and also with a view to an ultimate increase of the entire channel to this depth. The width of the 16-feet channel below Long Wharf is over 300 feet, the light-draught channel being over 400 feet.

The soundings on the bar below Fort Hale show a present depth of about 14 feet at low water.

In General Warren's report for 1874 it appears that, during the season of 1872–'73, a channel 200 feet wide was dredged upwards of 16 feet deep across this bar, where the available low-water depth was previously 11 feet; and in the same report it is stated that about 2 months subsequent to the completion of the work an examination indicated a depth of but 14½ feet, a result which appears almost unaccountable.

Since the date of that examination, November, 1873, but little shoaling has occurrred, and as there is now an available channel of 14 feet, the permanent gain in depth by the operations of 1872–'73 is about 3 feet. It is reasonable to presume that still better results would have been obtained had the cutting been made much wider, with gentle side slopes. It is highly probable, owing to the extremely soft nature of this bar, that any dredged channel will shoal more or less, as occurred in the previous case; but it is also to be presumed that a greater degree of permanence can be obtained by anticipating the subsidence of the banks, by sloping them back a considerable distance on either side, thus relieving the lateral pressure at the bottom, and making at the outset a cross-section similar to what would obtain after an equilibrium of the forces at work should have become established.

The improvement of this bar by one or more dikes is feasible, but the great expense attending this plan would preclude its recommendation until it is satisfactorily proven that dredging alone is insufficient to keep the channel open or is the more expensive method.

In view of all the circumstances, it is believed there is sufficient ground to anticipate that a substantial improvement can be made, and a depth of 16 or more feet maintained by dredging, to warrant the recommendation that further efforts be made to this end. To meet the present wants of the commercial interests of this harbor, I would respectfully propose that as soon as practicable the depth across the Fort Hale Bar and above Long Wharf be made 16 feet at mean low-water; the bar channel to be 500 feet wide, and that above 400 feet, except at the bend opposite Long Wharf, where an increased width should be given.

This plan is not proposed to replace that recommended by the chamber of commerce and board of harbor commissioners, and discussed in my report of January, 1875, but as a part of and preliminary to the ultimate execution of that more extensive and costly undertaking.

Following are estimates for the several amounts and costs of dredging for these improvements:

To deepen channel from Long Wharf to steamboat dock from 12 feet to 16 feet, 200,000 cubic yards to be removed, at 15 cents per cubic yard	$30,000
To widen the 16-foot channel below Long Wharf, including bend opposite wharf, 256,000 cubic yards to be removed, at 10 cents per cubic yard	25,600
To make channel through Fort Hale Bar 500 feet wide and 16 feet deep, 350,000 cubic yards to be removed, at 10 cents	35,000
	90,000

I am, general, very respectfully, your obedient servant,

J. W. BARLOW,
Major of Engineers, U. S. A.

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

There appears to be no element of uncertainty regarding the feasibility and probable permanence of that part of the improvement above the Fort Hale Bar. Here, however, arises a question as to the best and cheapest method of maintaining the desired permanence of depth.

The Fort Hale Bar is caused by the sudden widening of the harbor both to the eastward and to the westward. The tidal currents, in connection with the action of West River, have thrust a long, slender sand spit northward from the west side, just opposite Fort Hale, and about parallel with the east shore. In consequence of this formation, the harbor is here narrowed to about 3,200 feet, while above and below its width is more than double this distance. In this narrow portion of the channel the strength of the tides is sufficient to maintain a depth upwards of 18 feet at mean low-water, and if this reduced width of channel extended north or south probably the same depth would be created by the increased scour. And should the extension be carried far enough seaward to meet the littoral Sound currents, there is little likelihood of the formation of another bar. A further examination of the harbor has been made this season, chiefly with a view to ascertaining the strength and direction of the ebb and flood currents, and their influence in forming and maintaining the Fort Hale Bar. A report of the observations will be given in another place. From this examination it is inferred that the action of the flood tide has had some influence in producing this bar.

The bar being mostly soft mud, similar to the adjoining flats, its early renewal after the dredging of 1872–'73 has been accounted for upon the theory of subsidence. It is probable that this subsidence was partially caused by the same agencies which ordinarily produce a wave and drift bar. In southerly storms the waves at the mouth of the harbor have great height and power, resisting the outward movement of sediment, and partially neutralizing the ebb-current. During the flood a strong current sets in from the sound along the west shore, and before reaching the bar below Fort Hale is divided, a portion flowing directly up the channel, the remainder crossing over into Morris Cove. In rough weather this flood-current is beaten against the west shore, and in the movement along the beach and over the flats becomes the vehicle of more or less material, which sometimes is carried eastward as far as Fort Hale.

It would, therefore, seem that the erection of a dike from the west shore, just opposite Fort Hale, and running in a southerly direction below the position of the bar, would serve the double purpose of contracting the channel, and thus augmenting the power of the ebb-scour, and also of arresting the supply of the material brought in by the flood.

A dike as above, beginning at Sandy Point and continuing a distance of about 6,000 feet, would be a desirable adjunct in preserving a channel across this bar, and perhaps in assisting to produce one. Yet the great cost of such a structure leads me to renew the recommendation that the experiment of dredging be again tried over a wider channel than before. If it then be found that this channel shows a decided tendency to refill, the construction of the dike should be undertaken at once.

It will be observed from the recommendation heretofore presented that the most pressing and immediate requirements of this harbor are the improvements necessary to deepen the channel from Long Wharf to Steamboat Wharf and to increase the width below.

To this end the present appropriation will be directed. It is extremely important that the work be commenced without delay, and appropriations made for its continuation.

TOMLINSON'S BRIDGE.

By comparing tidal observations taken at Chapel-street bridge and at the light-house, it is seen that at the former place the rise and fall during neap tides, as well as the mean, are greater than at the latter.

The variations during spring tides, therefore, should be still greater at the upper point than at the lower. The reverse of this being the fact, *i. e.*, the rise and fall during spring tides being less at Chapel-street Bridge than at the light-house, proves that the movement of the tidal currents is hindered by an obstruction.

Tomlinson's Bridge with its long abutments and heavy piers allows a waterway of but about 325 feet, the width of the harbor here being about 1,400 feet. This bridge is, therefore, a serious obstruction, preventing the complete filling and emptying of the tidal reservoir above. The capacity of the bridge opening may be enlarged either by replacing a part of the east abutment by piers, or by substituting for the present piers, whose aggregate width is 155 feet, others of smaller size. The latter method is perhaps preferable, as the removal of the abutment would permit a wearing off of the east flat to the detriment of the channel below. It is certainly most desirable that the bridge be so modified by its owners as to admit of the free movement of the current to and from the upper tidal basin.

THE BREAKWATER AT THE HARBOR'S MOUTH.

The facts touching the importance of a breakwater at the entrance to the harbor, with a view to providing a secure refuge for all classes of vessels upon Long Island Sound, were presented in the last annual report, and at the last session of Congress the project for this work was approved by the appropriation of $30,000 with which to commence the structure. Upon this subject I can offer very little in addition to what has already been expressed, but would strongly urge the immediate application of the sum appropriated, and also recommend a further appropriation at the next session of Congress for continuing the work, the line proposed being that from Southwest Ledge to Quixes Ledge. The estimated cost of this work is $390,000.

Estimates have heretofore been presented, based upon plans advocated by those interested in the commerce of the city of New Haven and the improvement of its harbor, for dredging the main ship-channel to an extent costing from $208,000 to $416,000. The future exigencies of the harbor will undoubtedly demand improvements of this magnitude; but at present it is perhaps sufficient to provide a channel of 16 feet depth at low-water, with a width of 400 feet.

Dredging to that extent can be done at an expense of about $100,000, and would result in producing a harbor adequate to the immediate requirements of commerce. It is recommended that appropriations be made to this end, and that for next season's operations Congress be asked to make the following appropriations:

For dredging main ship-channel	$50,000
For continuing breakwater	100,000

Following are the several sums which have been appropriated for this harbor:

July 11, 1870	$15,000
March 3, 1871	40,000
June 10, 1872	20,000
March 3, 1873	25,000
March 3, 1875	10,000
June 18, 1878	25,000
March 3, 1879	15,000
March 3, 1879, breakwater	30,000

Valuable information bearing upon the subject of the improvement of this harbor is contained in the papers accompanying a letter of the Hon. Secretary of War, dated February 9, 1875, and published as House Ex. Doc. No. 162, of the Forty-third Congress, second session.

I would also refer to the commercial statistics of last year's report, which, though incomplete, show to some extent the immense traffic which is interested in a further improvement of this harbor.

New Haven is the port of entry for the collection district of New Haven; the amount of revenue collected during the year ending June 30, 1879, was $334,079.

There is a light-house on Southwest Ledge, at the mouth of the harbor. For Hale, 2 miles below the city, on the east shore, commands the channel entrance.

Money statement.

July 1, 1878, amount available	$26,944 62	
Amount appropriated by act approved March 3, 1879	45,000 00	
		$71,944 62
Suly 1, 1879, amount expended during fiscal year		24,132 12
July 1, 1879, amount available		47,812 50
Amount (estimated) required for completion of existing project		490,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1881		150,000 00

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, NEW HAVEN, CONN.,
Collector's Office, July 9, 1879.

SIR: I have the honor to return herewith the papers which you sent me in reference to the business of this port, together with the information asked for.

The importance of the harbor of New Haven as a place of refuge for vessels in storms is very great, as appears from the number of vessels entering the harbor for refuge during the year. The business of the port, too, is so large that the propriety of making further appropriations to improve and protect the harbor cannot be doubted.

Very respectfully, your obedient servant,

CYRUS NORTHROP,
Collector.

Maj. J. W. BARLOW,
New London, Conn.

Collections.

Duties on imports	$326,471
Tonnage dues	1,445
Hospital tax	2,236
Miscellaneous receipts	3,927
	334,079

	No.	Tons.
Number of foreign vessels arrived from foreign ports	28	6,281
Number American vessels arrived from foreign ports	19	6,339
American vessels arrived from foreign ports	52	10,543
American vessels cleared for foreign ports	15	2,568
Total number of vessels of all classes entered	910	
Total number of vessels of all classes cleared	797	

Total for fiscal year ending June 30, 1879, 1,707. Tonnage entered, 580,682; cleared, 569,911. Total, 1,150,593.

Estimated value of cargoes received	$673,706
Estimated value of cargoes exported	3,248,754
Number of vessels of all classes entering the harbor for refuge during the year	7,50