

The urgent recommendation of the Board that \$150,000 be at once appropriated to begin the work of closing the gap was not acted upon by Congress, and the existing evils still continue to augment, aggravated by the presence in the western portion of the harbor of 8 of the 10 wrecks that occurred during a fierce gale from the north-northwest on the night of October 4, 1877. The masts of one of these have fallen, and since January three vessels have struck upon it. The still projecting spars of the other 7 serve as day-beacons, but nothing marks their position in dark or stormy nights.

Petitions have been forwarded to Congress by the Philadelphia Chamber of Commerce, and by the pilots, captains, and vessel-owners of the vicinity, for an appropriation for their removal, which the shipping interest imperatively demands.

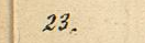
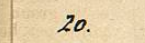
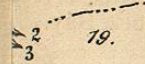
The appended statement of the number of vessels using the harbor shows that an average of 41 vessels has, since January 1, 1879, daily anchored either in the harbor or the vicinity.

It is to be hoped that the magnitude of the interests at stake, and the narrow margin of profit upon which our commercial marine maintains itself, will constitute an effective appeal for the development to and maintenance in its highest state of efficiency of this harbor, which offers the only point of safety in the whole stretch of 300 miles of treacherous coast that lie between Hampton Roads and New York Bay.

Table of current velocities, Delaware Breakwater Harbor.

In what part of harbor.	Station.	Maximum velocity, in miles, per hour.		Mean velocity, in miles, per hour.		Mean velocity of each group, in miles, per hour.	
		Flood.	Ebb.	Flood.	Ebb.	Flood.	Ebb.
Group I.—Between shore and east end of breakwater.....	No. 1	1.16	0.99	} 0.88	1.24
	2	0.72	1.58	0.44	1.32		
	3	1.35	1.65	1.13	1.41		
	4	2.39	1.81	1.53	1.11		
Group II.—In the gap.....	5	1.97	1.36	1.29	0.92	} 1.35	0.88
	6	1.57	0.77	1.23	0.61		
	7	1.87	1.92	1.32	1.13		
	8	1.14	1.54	0.73	0.98		
Group III.—Between west end of ice-breaker and railroad pier.....	9	0.93	1.45	0.72	0.89	} 0.75	0.93
	10	1.01	1.34	0.72	0.98		
	11	0.94	1.08	0.54	0.86		
	12	0.66	1.11	0.46	0.76		
Group IV.—In the central portion of the harbor.....	13	0.99	1.20	0.67	0.92	} 0.71	1.11
	14	0.91	1.36	0.71	1.17		
	15	1.14	1.61	0.76	1.24		

Mean velocity of currents on all the stations observed—flood 0.93, ebb 1.40 miles per hour.



The arro. Figures.

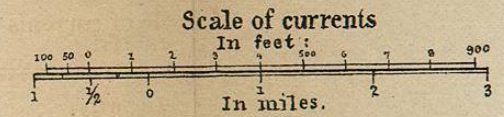
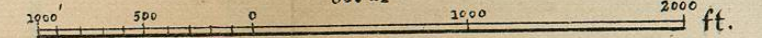
DELAWARE BREAKWATER HARBOR LEWES, DEL.

Showing location where current observations were made
and proposed improvement.

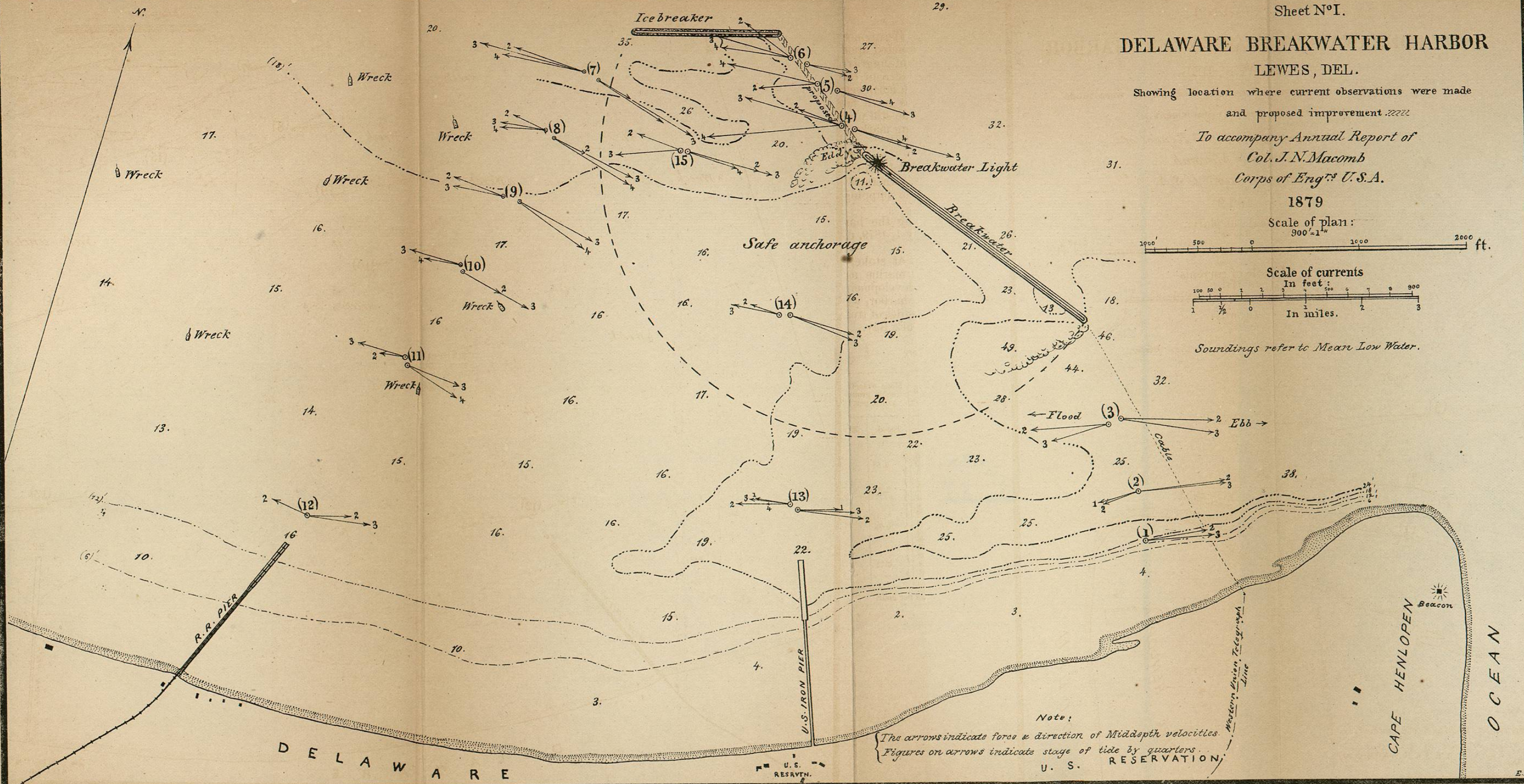
To accompany Annual Report of
Col. J. N. Macomb
Corps of Eng^rs U.S.A.

1879

Scale of plan:
900' = 1"



Soundings refer to Mean Low Water.

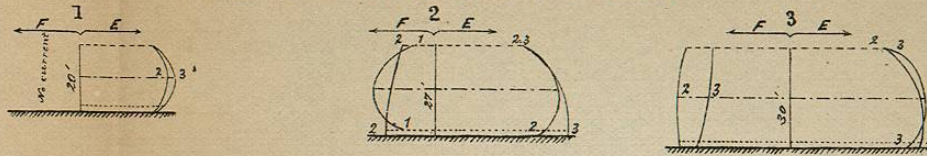


Note:
The arrows indicate force & direction of Middepth velocities.
Figures on arrows indicate stage of tide by quarters.
U. S. RESERVATION.

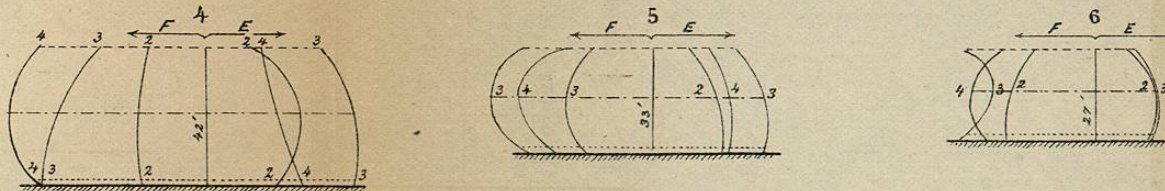
Sheet N^o II
 DEL. BREAKWATER HARBOR.
 VERTICAL CURVES OF CURRENT VELOCITIES
 1878

Horizontal scale 600ft=1inch, Vertical scale 60ft=1inch

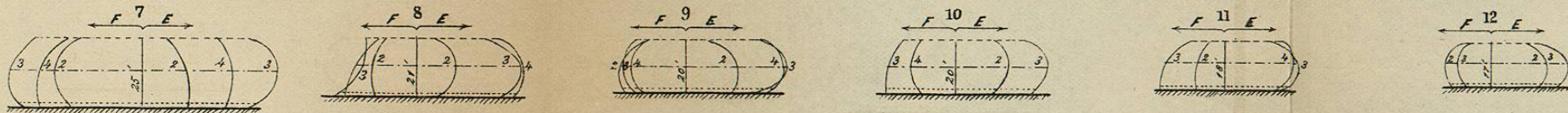
I.
 BETWEEN SHORE AND EAST END OF BREAKWATER



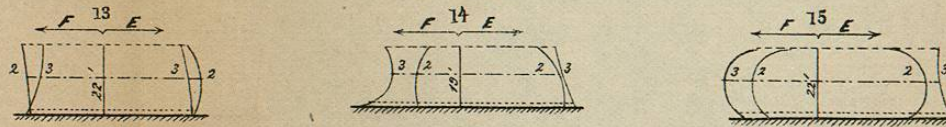
II.
 IN THE GAP



III.
 BETWEEN WEST END OF ICEBREAKER AND HEAD OF R. R. PIER



IV.
 IN THE HARBOR.



F over arrows indicates Flood
 E " " " Ebb
 Surface ----- } depths at which
 Middleph } currents were measured.
 Bottom }
 Depth of water shown is that of 2^d or 3^d quarter.
 Figures on curves indicate stage of tide by quarters.
 Curves drawn for maximum velocities only.

Statement of vessels anchoring in Delaware Breakwater Harbor from February 1, 1862, to July 1, 1879.

Years.	Steam-ers.	Ships.	Barks.	Brigs.	Schoon-ers.	Sloops.	Pilot-boats.	Total.	Remarks.
1862	246	55	239	879	8,087	253	.....	9,759	From February 1.
1863	347	231	345	1,040	7,092	251	.....	9,306	
1864	290	231	308	1,155	7,781	189	.....	9,963	
1865	372	274	378	1,179	6,056	209	.....	8,468	
1866	316	28	227	694	6,747	299	.....	8,311	
1867	279	113	290	825	8,000	307	.....	9,814	
1868	384	62	446	908	8,373	205	.....	10,378	
1869	342	42	256	658	9,017	696	.....	11,011	
1870	753	126	676	1,157	11,572	756	720	15,760	
1871	80	207	865	1,295	12,552	687	896	16,582	
1872	629	119	639	1,008	8,588	522	923	12,428	
1873	844	192	877	867	13,976	734	(*)	17,490	
1874	781	166	605	623	9,797	477	.....	12,449	
1875	843	222	804	581	9,527	420	.....	12,397	
1876	945	370	2,762	587	10,382	447	.....	15,493	
1877	1,092	558	4,146	626	10,027	370	.....	16,819	
1878	1,294	427	2,682	544	9,378	453	.....	14,778	
1879	791	287	1,452	395	4,232	244	.....	7,401	To July 1.
Grand total .	10,637	3,710	17,997	15,021	161,184	7,519	2,539	218,607	

* Pilot-boats classed with schooners.

LETTER OF THE ACTING CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., February 14, 1879.

SIR: In view of the present condition of the harbor at the Delaware Breakwater and the deterioration it has undergone, which is still in progress, and may at no distant day render it useless, except for the smaller class of vessels, I have the honor to submit herewith a copy of a report from a Board of Engineer officers to which the subject was referred by this office for its views and recommendations upon the questions involved in the preservation of the harbor.

The Board recommends, as a possible remedy, the closure of the gap existing between the breakwater proper and its adjoining ice-breaker, which it is believed will, to a greater or less extent, check further deposits within the harbor and remove those existing on the shoals in its vicinity, and will increase the protected area of anchorage nearly four-fold.

The cost of this cannot be precisely estimated without further study of the details of the work, but it is estimated at less than \$600,000; and the Board, believing that the necessity of giving full efficiency to this great harbor of refuge is urgent, recommend an immediate appropriation of \$150,000.

Fully concurring in the views and recommendations of the Board, I beg leave to suggest that, should it meet with your approval, this report be transmitted to Congress.

I also submit herewith a copy of the report of Capt. William Ludlow, Corps of Engineers, to which allusion is made in the report of the Board.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Acting Chief of Engineers.

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

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H. G. WRIGHT,
Acting Chief of Engineers.

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

REPORT OF BOARD OF ENGINEERS FOR FORTIFICATIONS.

OFFICE BOARD OF ENGINEERS FOR FORTIFICATIONS,
New York, February 8, 1879.

GENERAL: The Board of Engineers for Fortifications, with Col. J. N. Macomb, Corps of Engineers, as associate member, to whom was referred, by your letter of June 3, 1878, the subject of the growing obstructions in the harbor of the Delaware Breakwater, with instructions to examine into the remedies therefor suggested by Capt. William Ludlow, Corps of Engineers, have the honor to submit the following report:

Finding some further information touching the tidal currents in the harbor at Delaware Breakwater and vicinity desirable, a survey was ordered, the results of which were laid before the Board in December, 1878.

Having fully considered these results, and the maps and charts showing the condition of this harbor of refuge from time to time since its creation, as well as the various reports and discussions connected therewith, we are of the opinion that the most prudent course in relation thereto would be to close the gap between the breakwater and the ice-breaker, and thus greatly increase the extent of protected area for the anchorage of vessels.

The ice-breaker and breakwater, which are now separated by an open space of about one-quarter of a mile in extent, would then form a continuous mole, and the protected area for anchorage would be increased nearly fourfold.

In making the above recommendation, the Board refers to the fact that either the closure of the gap or the covering of it by an exterior work (a much more costly operation) has been recommended in every report since 1836, whether by Boards or individual officers; the majority of opinions being decidedly in favor of the closure. The present condition of the harbor and the observations as to the progressive deterioration it has undergone show that it will soon be useless, except for the smaller class of vessels, unless some remedial steps be taken to check further deposits and to remove those now existing on the shoals in the vicinity of the breakwater. It is expected that the closure recommended will produce both these effects to a greater or less extent. Until the results of such closure be determined, we deem it premature to discuss the other projects set forth in Captain Ludlow's letter for connecting the ice-breaker with the shore, or for shore protection of Cape Henlopen, as these works may prove unnecessary. At any rate, their extent and character, if required at all, will be understood when the closure of the gap in the breakwater has been tried.

We estimate the cost of closure of the gap as follows:

50,000 cubic yards riprap stone, at \$3.....	\$150,000
25,000 cubic yards dimension stone, at \$18	450,000
	600,000

The plan of construction being to build up from the bottom with riprap stone to 12 feet below low tide; then to 12 feet above low tide a wall with, say, 30-foot base and 12-foot thickness at top, with very large quarried dimension stone, or with concrete. It is believed that a further study of details of such a work will show that the cost will fall considerably within the amount of above estimate.

Believing that the necessity of giving full efficiency to this great har-

bor of refuge is urgent, we recommend an immediate appropriation of \$150,000.

Respectfully submitted.

J. G. BARNARD,
Colonel of Engineers, and Bvt. Maj. Gen'l.
J. N. MACOMB,
Colonel of Engineers.
Z. B. TOWER,
Colonel of Engineers, Bvt. Maj. Gen'l.
H. G. WRIGHT,
Lieutenant-Colonel of Engineers, Bvt. Maj. Gen'l.

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

NOTE.—The papers and drawings referred to the Board in connection with this subject are returned herewith.

REPORT OF CAPT. WILLIAM LUDLOW, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Philadelphia, May 15, 1878.

COLONEL: In accordance with the instructions given in your indorsement of May 2, on the paper herewith returned, I have the honor to submit the following report on the condition of the Delaware Breakwater Harbor, as shown by my survey of November, 1877.

The chart of this survey has been submitted; but in order to show clearly the changes that have taken place in the harbor since its construction, I have prepared the accompanying comparative chart, carefully compiled from tracings of the original maps in each case, and believed accurately to represent them on a common scale of $\frac{1}{3600}$.

The survey of 1828, by Lieutenant Sherburne, U. S. N., previous to the commencement of the works, is that from which the positions of the ice-breaker and breakwater were designed. That of 1842 was made under direction of Major Bache, then in charge of the construction of the harbor; that of 1863 by the Coast Survey, and that of 1877 by myself in November last.

On Major Bache's chart the plane of reference is that of extreme low-water of spring tides; the high-water line, that attained by extreme high-water of spring tides.

The curves of the other charts are referred to the usual planes of reference, viz, those of mean high and mean low water.

Making allowance for this difference, which is not now susceptible of correction—and in fact is not material when understood—it appears from a comparison of the relative positions of the several sets of curves that the changes indicated have been in progress constantly, though not uniformly, during the entire period of forty-nine years from 1828 to 1877.

Though not in themselves specially remarkable in character, nor even unusual in extent, these changes are both significant and important, when considered in relation to the harbor of refuge which they affect. It would seem also that the period during which the recorded alterations have been progressing is sufficient not only to show the tendency of the forces at work, but to justify an anticipation of their future