

Observations in 1887.—In April, 1887, the west breakwater was built out a distance of 1,350ft., but the east one was not commenced. At this time I had several lines of soundings taken. From these and the plan of low-water mark it is seen that great changes had taken place from the condition of things in 1879.

Changes in Beaches.—On the west beach the low-water mark had extended seaward, in a long point, to a position close to the line of the breakwater, and a little further out than the low-water line is at present. On the east beach low-water mark had extended seaward farther out than it is now, but in the form of a rounded point 1,500ft. away from the line of the east breakwater, and leaving a deep bay between the point and the end of the old training-wall. Between 1887 and 1892 the low-water line at the east and west beaches have become straightened, and even several chains inshore of the protrusions found in 1887, but on the east side of the east breakwater a narrow tongue of sand has crept out to the end of the wall.

Great Shoaling.—In 1887, in addition to the above changes in the low-water line, the sea-bottom outside had shoaled very remarkably all round the river-mouth compared with the depth in 1879, and the effect of the breakwaters has been in 1892 to deepen the shoaling of 1887. The following list of depths will show this:—

LIST of Depths in Feet at Low-water Spring-tides.

Depth 6 chains out from end of west wall—

	East Wall.	Centre Line.	West Wall.
1879	23·0	25·0	25·6
1887	9·6	7·0	13·0
1892	16·0	19·0	15·0

Depth 14 chains out—

1879	31·0	31·6	31·6
1887	14·0	14·0	15·0
1892	17·0	20·0	21·0

Depth 20 chains out—

1879	36·0	36·0	36·0
1887	19·0	20·0	21·0
1892	21·0	23·6	26·0

Depth 24 chains out—

1879	38·0	38·0	37·0
1887	23·0	22·0	26·0
1892	23·0	25·6	28·0

Supposed Origin of the Changes.—These changes, I believe, commenced after the river broke out a new mouth in 1872. The various surveys of low-water mark show that from 1875 to the present time incessant alterations in the west and east beach lines have been going on, but much more on the east beach. Before the breakwaters were built the tendency of the changes was evidently for the east beach to extend and encroach on the river-channel, so as gradually to assume the form of entrance that existed before the river broke out, but farther seaward of the old entrance. The completion of the breakwaters has apparently steadied the west beach; but the east beach, although it appears settled, has a great shoal-spit protruding seaward as appears from the line of breakers, which shows that on the west beach there is shallow water about 300ft. outside the end of the west wall, extending in a straight line towards Carter's house. At the east beach the shoal projects as a spit 600ft. or 800ft. beyond the end of the east wall, and 600ft. eastward of it, leaving a bay of deeper water between the end of the spit and the wall. There is also an island-shaped shoal with 12½ft. of water between the ends of the walls, rather nearer the east than the west wall, and there is a channel with 15ft. to 17ft. of water between the island and the end of each breakwater. Shoals are thus seen to form on each side of the current out of the river, that on the east being much farther out, and more extensive, and they have a tendency to encroach on the channel between the walls, as shown by the island-shaped shoal in the channel.

Reason for Formation of Shoals.—This condition of things, I believe, is owing to the position of the east beach being under the shelters both of the walls and of the outflowing current of the river, and the fact of the west wall being 400ft. in advance of the east wall allows the shoals to encroach on the channel. The east side of the harbour-mouth must always have the greater amount of deposits forming shoals. The strong outflow of the river diverts the easterly set of the shore-currents, and slightly checks the violence of the waves: this allows the sand drifted from the west beach crossing the mouth of the harbour to deposit on the east side, and, in addition, all sand brought out of the river is deposited on the east side of the east breakwater.

Observations by Floats.—As the sand which forms these shoals is carried by currents flowing near the bottom, I took a number of observations with floats sunk too near the bottom and others at the surface of the water. On the 22nd June the river was low, and high water occurred at 7.50 a.m., with a west wind and westerly sea. A little after high water a ground-float dropped at west breakwater drifted out in a N.N.W. direction, and a ground-float dropped at the east breakwater drifted out towards N.N.E., but, as the tide fell, ground-floats from either wall drifted towards the N.E. Surface-floats did not vary much in direction to the ground-floats. On the 23rd June, with a brisk wind at N.N.E., and westerly sea at half-ebb, a ground-float drifted out in a N.E. direction, and a surface preceded it in the same direction.

Indication from Them.—These observations, so far as they go, show that the water flowing out from the walls spreads like a fan, but always tends towards the east.

Velocity of Currents.—The weather was too rough to take observations of the velocity of currents outside the heads, which would have been interesting and instructive. On the 22nd of June the river was low, but there was the last remains of a slight fresh, the tide was at half-neaps, and