chart, so as further to regulate the flow, and keep the new channel free from drifting sands that may be brought in by the northwest winds. The tops of these walls should be built to 3 feet above low-water, with abutments at their sea-ends carried up to above high-water level.

The prevailing winter winds, which are the most boisterous, are those from the southwest, and make the entrance, as it is now, very dangerous. Vessels are forced to run through a narrow channel with their broadsides to the wind; but if the channel be regulated by the training-wall, as proposed, the danger would be greatly decreased, and the entrance made comparatively safe. In the construction of the training-walls stone or other material will have to be used which are proof against sea insects, as they are very destructive in the bay. The wharf-piles at Empire City, 4 miles from its entrance, are badly cut by them.

The following is an approximate estimate of the cost of proposed improvement:

Southern training-wall, 8,000 feet, at $70 per foot	$560,000
Northern training-wall, 5,000 feet, at $70 per foot	350,000
Two abutments, at $8,000 each	16,000
Contingencies, 5 per cent	46,000
Total	972,000

Respectfully submitted.

CHANNING M. BOLTON,
Assistant Engineer.

Col. JOHN M. WILSON,
Corps of Engineers.

KK 7.

EXAMINATION OF CAPE FOULWEATHER HARBOR, OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., September 23, 1878.

GENERAL: I have the honor to transmit herewith a chart of Cape Foulweather Harbor, Oregon, together with the report of Mr. R. A. Habersham, assistant engineer, and to submit the following report of an examination and survey made under my direction in accordance with the act of Congress approved June 18, 1878.

OBJECT OF THE EXAMINATION.

The object of the examination and survey of this harbor was "to ascertain its adaptability as a harbor of refuge."

Early in August I organized a party for this work and placed it in charge of Mr. R. A. Habersham, assistant engineer, with orders to proceed to Cape Foulweather and make the necessary surveys to carry out the law. This party proceeded to Corvallis, Oreg., via the Willamette River; thence by wagons across the Coast Range of mountains to Newport on Yaquina Bay, and thence to Cape Foulweather, where they camped until the survey was completed. On September 8 I visited Cape Foulweather and made a general examination of the locality.

DESCRIPTION OF THE HARBORS.

Cape Foulweather is situated on the western coast of Oregon, in latitude 44° 43′ north, longitude 124° 05′ west, and forms a headland boldly jutting out about three-fourths of a mile into the sea from the low beach, with high mountains in rear of it.

It is a mass of black basalt rising to a height of from 80 to 100 feet above the sea, the base honeycomed with caves formed by the action of

the waves. The cape, by its position, forms bays on the north and south, the one fronting northwest and the other south and southwest. On the north the shore-line is crescent-shaped, the outer extremity pointing north, a reef making out from it in a direction north-northeast a distance of about 5,000 feet, terminating at a lone rock about 1,800 feet from the beach; the depths on this reef vary from 10 to 30 feet, except for a distance of about 1,200 feet near the cape, where there is a channel of that width with a depth of from 30 to 40 feet. The lone rock referred to at the north end of the reef seems to be connected with a rocky point opposite on shore by a well-marked reef, upon which there is a depth of four fathoms.

The north bay is inclosed, therefore, on the east by the mainland, on the south by the cape, and on the west by the long reef. It is nearly a mile long, and about 1,700 feet wide between the 3-fathom curve and the reef. It contains about 200 acres, with a depth of from 3 to 8 fathoms, and a sandy bottom. As far as could be judged, there is good holding ground for anchoring vessels, although I understand that no vessel has ever entered.

This south bay is formed by the main shore and the cape, and is protected on the east, north, and northwest. On the south and southwest it is open and exposed to the terrible southern gales, from which it is most desired to find shelter. The bottom is sandy, the depth gradually increasing from near the shore, where it is 3 fathoms, to 20 fathoms 2 miles off shore. The general depth on a line drawn south from the cape is from 4 to 6 fathoms.

TIDES, FOGS, ETC.

The spring tides rise and fall about 9 feet. Dense fogs overhang the cape from time to time during the year, particularly during the month of July.

THE HARBOR OF REFUGE.

About 3½ miles south of Cape Foulweather is Yaquina Bay, the mouth of Yaquina River. A railroad is projected to connect this bay with the Willamette River. It is anticipated that when this is completed a large amount of grain and other produce now finding its way to market via the Willamette and Columbia Rivers will seek an outlet via Yaquina Bay.

About three-quarters of a mile off the entrance to this bay a dangerous reef of rocks, extending in a north and south direction, with many narrow and dangerous channels across it, is reported by the Coast Survey, and laid down on their charts. I am informed that the residents in the vicinity presumed that a reef extended from Yaquina Head toward the cape, and inclosed an area of about 1,000 acres, the ridge being, they thought, well defined, and that upon it a breakwater could be constructed which would form a fine harbor of refuge.

As far as I could learn, the object of this survey was to locate a breakwater upon this supposed reef for a harbor of refuge.

The chart of the United States Coast Survey shows no such reef, and the very careful examination of Assistant Engineer Habersham reports four knobs of rock apparently much harder than the rest of the bottom from 12 to 30 feet under low-water level situated in a curved line in the direction above indicated, but distant from each other from one-fourth to one-half a mile and with from 6 to 8 fathoms of water between them. On these during low-tide and heavy weather the sea breaks constantly.

The chart transmitted herewith shows a breakwater projected on this line, starting from near Yaquina Head and running west, then curving to the north, and terminating about a mile and a half from the cape. Such a harbor would present a large area amply protected from southwest gales, with a depth of from 3 to 8 fathoms. The cape proper already presents a good protection from gales from the north and northwest. This breakwater would be about 9,900 feet long, and constructed upon the plan adopted by the Board of Engineers for the Pacific coast. It is described in their report of February 14, 1877, as follows:

> We propose to build the base of any breakwater up to the height of 15 feet below the level of low-water of small stone; that is to say, of such stone as any quarry will furnish, and while quarrying out this great mass to lay away all large stones of 5, 10, or 20 tons for the construction of that portion of the breakwater from 15 feet up to low-water. Upon this foundation we propose to build a masonry wall faced with granite 25 feet wide and 20 feet high, including foundation, protecting the seaward side by blocks of artificial stone (if natural cannot be obtained) of large size (20 to 30 tons each) and thoroughly paving the harbor side with large blocks of granite to receive without displacement the water that will be thrown over the wall in great storms.

The cost of such a breakwater is estimated by Assistant Engineer Habersham to be as follows:

9,900 feet, at $1,052.57 per foot	$10,420,443 00
Contingencies, 10 per cent	1,042,044 00
Total	11,462,487 00

It is highly probable that for present purposes a breakwater would be sufficient starting from Yaquina Head, running on the line projected, terminating in 4½ fathoms water and having a length of 4,900 feet; such a work would cost as follows:

4,900 feet, at $854.57 per foot	$4,187,393 00
Contingencies, 10 per cent	418,739 00
Total	4,606,132 00

Such a breakwater would present an area of about 200 acres protected from gales from the south and southwest. The difficulty to be contended with in using this harbor would be that sailing-vessels entering during a southwest gale would be obliged in rounding the outer end to face the wind.

Assistant Engineer Habersham made a careful examination of the bay north of the cape; no survey has ever before been made, it is believed, of this bay, and as far as he could learn his boat was the first that ever entered it. He reports that it is a natural harbor of considerable extent without further improvement, and that he was informed that during southwest gales quite an area inside is comparatively smooth. Several of the seamen who were employed as boatmen on the survey, who had sailed for a number of years between San Francisco and Puget Sound, and claimed to be familiar with the coast, said that if buoys were placed to mark the entrance, vessels could now enter for shelter from southwest gales. From the examination made under my direction by Assistant Engineer Habersham, and from his report and my own observation, I think a better harbor can be made north of the cape than south of it, by constructing a breakwater running in a northwest direction just inside the reef running out from the cape; such a breakwater would be about 600 feet long and would contain within it an available anchorage of from 50 to 100 acres with a depth of from 3 to 8 fathoms.

The plan for such a work would be similar to that already described, and the cost is estimated by Mr. Habersham at $656,251.

The harbor could be greatly increased in size by constructing a breakwater on the reef parallel to the shore already described.

This north harbor, with the 600 feet breakwater, would only be available in south and southwest gales; but during heavy weather from the northwest, vessels could anchor on the other side of the cape.

Attention is respectfully invited to the interesting report of Assistant Engineer Habersham transmitted herewith. In making the examination there were numerous minor difficulties to overcome, and Mr. H. deserves credit for the efficient manner in which he carried out my instructions.

Cape Foulweather is in the collection-district of Southern Oregon. The nearest port of entry is at Newport, Yaquina Bay; no revenue was collected during the last fiscal year; there were no foreign imports or exports; about 600 tons of assorted merchandise are brought in annually by coastwise vessels, which carry away lumber and oysters; two sailing-vessels, of about 100 tons burden each, with a draught of 9 feet, are running between San Francisco and Yaquina Bay.

There is a first-order light-house on the cape, visible 19 miles. The nearest works of defense are at the mouth of the Columbia River.

The value of the commerce to be benefited by this work would run up into millions, as the benefit would be felt by every vessel navigating the Pacific Ocean between San Francisco and the Strait of Fuca.

For the necessity for a harbor of refuge on this Northern Pacific coast, I respectfully call attention to the interesting and elaborate report of the Board of Engineers for the Pacific coast dated February 14, 1877.

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

JOHN M. WILSON,
Major of Engineers, Brevet Colonel, U. S. A.

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

REPORT OF MR. ROBERT A. HABERSHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., September 16, 1878.

COLONEL: I have the honor to submit the following report of a survey "at Cape Foulweather, to ascertain its adaptability as a harbor of refuge," with a general plan of improvement, and an approximate estimate of its cost, made in pursuance of your instructions dated August 8 of the present year.

This work was performed between the 9th and 23d of the same month. To save repetition, I will here state that all depths given refer, unless otherwise specified, to the lowest of mean low tides, as nearly as could be determined from the tide-tables for the Pacific coast, published in San Francisco, and from information furnished by residents of the locality.

No extreme tides occurred during the progress of the survey, not even at full moon, an unusual circumstance.

TOPOGRAPHY AND HYDROGRAPHY AT CAPE FOULWEATHER AND ITS VICINITY.

From Yaquina Head, which marks the north side of the entrance to Yaquina River, the shore-line runs a little to the east of north for 4 miles, to the end of South Foulweather beach; thence westward for three-fourths of a mile to the southwest elbow of the cape, where it begins to curve northward and eastward until it reaches the extreme point of Cape Foulweather, which points north; thence southeast, curving round to east, to the point where the cape joins the mainland again; thence north for about 7 miles to a point known as Old Cape Foulweather.

The shore-line of Cape Foulweather proper describes the figure of a half crescent, the curved tip pointing north. From this point a reef makes out in a nearly direct line, course north-northeast, for 5,025 feet, terminating in a bare rock, which, for convenience, I have called Round Rock, distant 1,800 feet from the low-tide line on the north beach, and immediately opposite Rocky Point, a vertical cliff formed of rock of the same character, of which it was formerly a portion, as the soundings show a well-marked ridge connecting them about 4 fathoms under water.

The depths on this long reef, which is nearly flat on its crest, vary from 10 to 30 feet from Round Rock to within 1,200 feet of the cape, where a depression occurs which shows from 30 to 40 feet, the center being the deepest. The north side of this gap is marked by a rock on which the swell breaks constantly, and which is said to be bare at extreme low tide.

It is seen that the cape forms two bays, one fronting northwest, the other south and southwest. The north bay, the outlines of which have just been given, is inclosed on the east by the mainland, on the south and southwest by the cape, on the west by the long reef, and on the north by the reef which connects Round Rock with Rocky Point. It is nearly 1 mile in length and ¼ of a mile across, the width being measured from the curve of 18 feet depth to the west reef, and contains about 200 acres. The bottom is sandy, generally smooth, forming good holding-ground as far as can be judged, no vessel or craft of any kind having up to this time entered here, that I can learn. The depths vary from 3 to 8 fathoms.

The south bay, so called, is open to the south and west. It is bounded on the north by the cape, and on the east by the mainland. The bottom is sandy, sloping seaward; the depth increasing uniformly from near the beach, where it is 18 feet, to 20 fathoms at a distance of 2 miles from the shore. The general depth on a line drawn south from the cape is from 4 to 6 fathoms; it is rather a roadstead than a bay; and while it is easy of access from the ocean in any direction, is sheltered only from north and east winds, which are never violent.

From Yaquina Head to the north end of Foulweather beach the shore presents a slope of from 50° to 80°, tolerably uniform in direction generally, but much broken by sharp points, and by ravines and small valleys. The face of the cliff shows soft sandstone, overlying at greater or less depths a bed of marl, filled with fossil shells. Numerous small veins of water trickle down the face of the sandstone, softening it, and contributing to the destructive action of the weather, while the marl underneath is also wearing away under the heavy blows of the surf.

Between Yaquina Head and the cape four streams large enough to furnish good water-power flowing through small valleys more or less heavily timbered, enter the ocean. Except in these valleys the vegetation, although luxuriant, is of small growth, and consists or salal, whortleberry, fern, and scattering spruce shrubs. The beach is from 300 to 800 feet wide, generally sandy, but the frequent occurrence of rocks above the surface shows that the sand has little depth. The shore north of the cape is of the same general character.

Cape Foulweather is a promontory, covered with a thick carpet of grass and fern, making out from the continent, its crest line running from east to west, at right angles to the general course of the shore-line, crossing two conical summits respectively 400 and 350 feet high, descending the latter at a slope of about 30° and terminating in a flat point 80 feet above mean sea-level, on which the light-house stands. The neck where the promontory joins the continent is 2,300 feet across between low-water lines and about 200 feet above sea-level at its highest point. The promontory is a mass of dense, hard, black basalt, which seems to have been forced like a wedge into a cleft in the sandstone. It rises vertically from the sea to a height of from 80 to 150 feet, in many places overhanging the water; its face hollowed out into caverns and seamed with fissures, with sharp projections of fantastic shape; the whole crumbling away slowly from the effects of the winter frosts and rains. The base of the cliff is honeycombed with caves, some of which might well be called tunnels, as they extend a long distance into the rock. One is said to penetrate 80 feet in a direct line from the face. It was not possible to verify this statement by measurement, as the surf was washing in and out of the cave with great force, but it is probably not far from the truth. The west end of the cape is surrounded by a number of pinnacles of rock rising vertically to a height of from 40 to 80 feet out of the water. Seen from a boat at a short distance, this black jagged mass towering into the air, with the surf lashing its base with a noise like thunder, the scene excels in grandeur the sight of Devil's Cañon and Cape Horn, on the Central Pacific Railroad; but it must be a sight of terror to the unfortunate mariner who should see it as a lee coast during the southwest gale.

WEATHER.

From November to April the prevailing winds are southerly. Sometimes strong west winds occur, changing round to northwest, breaking into heavy squalls, accompanied by rain, hail, thunder, and lightning. This is generally from February to April. The gales which are principally dreaded by mariners come from the southwest. These are sometimes so strong that a man cannot keep his feet, and pebbles as large as hazelnuts are caught up from the beach and dashed against the light tower, a height of more than 100 feet. The gales reach a velocity of 60 miles per hour. Fogs so dense that the shore is not visible from a distance of 500 feet out at sea occur at all seasons, but principally during the month of July. Rain during the winter is not so frequent as in the Willamette Valley, but heavier; snow is of rare occurrence, always light, and soon melts.

For the information contained in this paragraph I am indebted to Capt. S. P. Wass, custodian of the light-house at Cape Foulweather.

TIDES.

The spring tides, with the ocean in its normal condition, rise and fall 9 feet. During strong west winds the high tides have reached a height of 12 feet above mean low-water mark. The influence of ordinary high tides extends to Pioneer, 30 miles above the mouth of the Yaquina, the tide rising and falling from 4 to 6 feet.

LOCATION FOR A HARBOR OF REFUGE.

It has generally been believed by the residents of the country around Yaquina Bay that a reef from 3 to 5 fathoms under water extends in a curved line from Yaquina Head towards Cape Foulweather, terminating about one and a half miles south of the cape, inclosing a basin having a smooth, sandy bottom, which covers an area of nearly 1,000 acres, and that a breakwater built along the crest of the supposed reef would convert the basin into a harbor of shelter for vessels in distress, as well as a port of entry.

It was for the purpose of ascertaining the feasibility of this project that a survey was requested by those interested, among whom may be included all of the people of that section of Oregon whose nearest outlet to the ocean lies through the valley of the Yaquina River. The chart of the United States Coast Survey in this locality, and my soundings over the same ground, show that no such reef exists. There are 4 knobs of sandstone, harder than the rest of the bottom, from 12 to 30 feet under low-water level, situated in a curved line in the direction above indicated, but distant from each other from ¼ to ½ a mile, and with from 36 to 50 feet of water between them. On these, during low tides and heavy swells, the sea breaks constantly, suggesting the presence of a continuous reef.

The length of breakwater which this project contemplates would be 9,900 feet, with an average depth of 26 feet below low-tide level.

Its cost per linear foot, on the general plan recommended by the Board of Engineers, Pacific coast, would be as follows:

Ashlar masonry, 21.67 cubic yards, at $18	$410 60
Rubble masonry, 14.08 cubic yards, at $9	126 72
Small rough rubble, 73.00 cubic yards, at $3	219 00
Large rough rubble, 59.25 cubic yards, at $5	296 25
Per linear foot	1,052 57
9,900 linear feet, at $1,052.57	10,420,443 00
Add for contingencies 10 per cent.	1,042,044 30
Total	11,462,487 30

The estimate for rough rubble may appear excessive, but the stone would have to be brought from Cape Foulweather, the nearest point where hard rock is found, and where, owing to the prevalence of heavy seas, the loading of barges would be expensive and dangerous, often impossible, necessitating the suspension of the work until the recurrence of smoother water should allow the boats to approach the quarries with safety.

There is no question that such a work, if carried out, would greatly benefit navigation by affording shelter from southwest gales. Some such protection is absolutely required. But a better harbor, at much less cost, would be secured by building a breakwater from the extreme point of Cape Foulweather northward, inside of the reef above described, for a distance of 600 feet. This would inclose an area of about 100 acres, under the lee of the cape, with good anchorage in from 4 to 8 fathoms of water, having a free entrance from the west 1,200 feet wide. Such a harbor would satisfy present necessities, not only as a refuge but also as a port of entry; Yaquina Bay being accessible only to light-draught coasting vessels; and it might be enlarged at any future time if desired, by extending the breakwater along the reef.

The cost per linear foot of a breakwater here, on the plan recommended, would be, as nearly as can be estimated from the data obtained, as follows, its dimensions being: Length, 600 feet; average depth below low tide, 31 feet.

Ashlar masonry	$410 60
Rubble masonry	126 72
Small rough rubble, 110 cubic yards, at $2	220 00
Large rough rubble, 59.25 cubic yards, at $4	237 00
Per linear foot	994 32
Making for its length of 600 feet	596,592 00
Add for contingencies 10 per cent.	59,659 20
Total	656,251 20

Here the stone could be obtained from the shore end of the wall and hauled in cars along the top, extending the track as the work progressed, making the cost of transportation less than in the south bay. The above estimates are in gold coin.

The hydrographic work of the Coast Survey in this vicinity terminates at the extremity of Cape Foulweather. No survey had ever been made of this bay, and, so far as I could learn, my boat was the first that had ever entered it. It is a natural harbor of considerable extent, even without improvement. I am informed that during southwest gales the whole of the area inside of the reef is comparatively smooth, and the southeast portion quite so. Several of the seamen employed as boatmen on this survey, who had sailed for a number of years between San Francisco and Puget Sound, and claimed to be familiar with the coast and its climate, said that if two buoys were placed to mark the entrance, and the fact published for the information of mariners, vessels of any draught could enter here, not only for shelter, but for purposes of commerce. If this opinion be correct—and there seems to be no reason to the contrary—the circumstance is of interest in connection with the fact that a narrow-gauge railway is now under construction from Corvallis, on the Willamette, to Yaquina Bay.

Last winter there were a number of vessels in distress off Cape Foulweather at different times, and one that I am aware of was lost, with all on board. In describing this bay I omitted to mention that there is a rock on which the swell breaks during westerly and northerly weather. It is small, and lies about 500 feet from the mainland, nearly opposite the entrance. It is not in the way of vessels anchoring.

Learning that a cove, with good anchorage, existed about 10 miles north of the cape, and wishing to get all information possible on the subject of a refuge, I went there by sea, two members of my party being familiar with the spot. I found it to be an indentation in the rocky coast, three-fourths of a mile long and about 1,000 feet wide; its longer diameter parallel to the general direction of the coast-line with from 6 to 10 fathoms depth, well sheltered from north wind, but open to the west and southwest. This place is called Wrecker's Cove; the name having been given by men who saved, or rather collected, some fragments of the schooner Uncle Sam, lost a mile north of the cove about two years since.

Respectfully submitted.

ROBERT A. HABERSHAM,
Assistant Engineer.

Col. JOHN M. WILSON,
Major, Corps of Engineers, U. S. A.

KK 8.

EXAMINATION OF PORT ORFORD HARBOR, OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., September 23, 1878.

GENERAL: I have the honor to transmit herewith a chart of Port Orford Harbor, Oregon, and to submit the following report of an examination made by me in accordance with the act of Congress approved June 18, 1878:

OBJECT OF THE EXAMINATION.

The object of the examination of this harbor was "to ascertain its adaptability for a harbor of refuge."

I left Portland, Oreg., on the morning of September 2, 1878, for Port Orford, 330 miles distant, reaching the latter place on the evening of September 4, the journey requiring three days.

I fortunately had a fine opportunity to judge of the capacity and availability of the harbor, as I entered it from the Pacific Ocean during a northwest gale, and our vessel anchored in 7 fathoms opposite "Battle Rock," in smooth water.

I remained two days at the harbor, during which I made a careful examination of it and its surroundings, and conversed freely with all parties who were acquainted with its general character and the force and direction of the seas from which it needs protection.

DESCRIPTION OF THE HARBOR.

Port Orford, the most westerly port of the United States south of Alaska, is situated on the western coast of North America, in latitude 42° 44′, longitude 124° 29′, and according to the Coast Pilot of Oregon, published by authority of the Coast Survey, is by far the best summer roadstead on the Pacific coast, between Los Reyes and the Strait of Fuca.

The harbor is deep and capacious, and is formed by a headland boldly jutting out into the sea, nearly vertical on its water face, the portion forming the shelter from westerly gales attaining an altitude of about 350 feet; from the outer point the ground slopes gradually down to an elevation of about 60 feet above low-water, near the northern part of the bay, opposite which the town of Port Orford is situated.

The survey made by the Coast Survey, and plotted on their chart, is reported as follows by the Coast Pilot: "From the extremity of the southwest point eastward to the main shore, the distance is two miles, and from this line to the greatest bend of the shore northward the distance is one mile.

"The soundings within this space range from 16 fathoms close to Tichenor's Rock, forming the southwest point of the bay, to 3 fathoms within one-fourth of a mile of the beach on the northeast side, with 5 fathoms at the base of the rocky points on the northwest side toward Tichenor's Rock; one mile off the shores of the bay the average depth is about 14 fathoms, regularly decreasing in-shore."

From my own examination and all the information I could collect, I find the bottom of the harbor to be of sand and mud, presenting a good holding-ground, and that there are no sunken rocks or hidden reefs to endanger vessels after getting inside the head. It is said that northwest fogs seldom, if ever, enter the roadstead, which gives it, consequently, a great advantage over other harbors on the coast south of the Columbia River.

From my own observation I am led to believe this is so. While off the coast between Cape Arago and Port Orford, a dense fog enveloped the shore; but when we reached Cape Blanco this seemed to veer off and follow the line of the reef north of Orford, and we entered the harbor, where it was perfectly clear. On the following day, while examining the coast north of Orford on shore, I found a dense fog enveloping Cape Blanco, seven miles north, while at Port Orford it was perfectly clear and pleasant.

TIDES.

The mean rise and fall of tides is $5\frac{1}{10}$ feet; of spring tides, $6\frac{8}{10}$ feet; and of neap tides, $3\frac{7}{10}$ feet.

DANGER IN ENTERING THE HARBOR.

Between Port Orford and Cape Blanco, and about three miles off the coast, there is a group of rocky islets and sunken rocks called Orford Reef, which renders the approach to Port Orford from the north somewhat dangerous; there is, however, a good wide ship channel between this reef and the main shore.

GENERAL REMARKS.

In reference to the present condition of the harbor during winter gales, the Coast Pilot notifies mariners as follows:

In winter, anchor far enough out to put to sea when a southeaster comes up; during a protracted gale in December, 1851, a terrible sea rolled in that no vessel could have ridden out.

The old steamer Seagull was driven northward, and lost two weeks in regaining her position, and the mail steamer Columbia hardly held her own for many hours off Orford Reef.

In the fall of 1872 Maj. H. M. Robert, Corps of Engineers, made a careful examination of this harbor, and in January, 1873, presented an elaborate report, with plans and estimates, for a breakwater. In the summer of 1876 the Board of Engineers for the Pacific Coast made a similar examination, and in February, 1877, presented a report, with a plan and estimates; these very interesting reports were laid before Congress, and to them I respectfully call attention for details.

CONCLUSIONS.

After a careful examination of this subject I beg to report that, in my opinion, Port Orford is a very available point for a harbor of refuge. It is easily accessible, occupies a position nearly midway between San Francisco and the Strait of Fuca, presents a deep and capacious roadstead, offering secure anchorage from gales from all points except south, southeast, and southwest; is not subjected to northwest fogs, has no shifting sand bars or hidden reefs within its limits; the land around is high and prominent, and presents all the necessary materials, easily accessible, for a stone breakwater. All that is now needed to make it a secure harbor of refuge at all seasons is a breakwater, behind which vessels can ride safely at anchor during gales coming from the southeast, south, and southwest, from which it is not already protected by nature.

A careful examination of the chart of the currents and the general direction of the gales leads me to the conclusion that a breakwater about 5,000 feet long, running from the outer point of the Head toward Coal Point, would give ample protection to a large fleet during the heaviest gales; for present purposes 2,000 feet would be sufficient, and this could be extended whenever it became necessary.

A breakwater 5,000 feet long would secure a harbor of about 300 acres, with a depth of from 4 to 12 fathoms outside the 3-fathom curve, while one of 2,000 feet in length would secure an available anchorage of about 90 acres with the same depth.

The plan of breakwater recommended is that proposed by the Board of Engineers for the Pacific Coast and described in their report of February 14, 1877, as follows:

We propose to build the base of any breakwater up to the height of 15 feet below the level of low-water of small stone, that is to say, of such stone as any quarry will furnish, and while quarrying out this great mass to lay away all large stones of 5, 10, or 20 tons for the construction of that portion of the breakwater from 15 feet up to low-water. Upon this foundation we propose to build a masonry wall, faced with granite, 25 feet wide and 20 feet high, including the foundation, protecting the seaward side by blocks of artificial stone (if natural stone cannot be obtained) of large size (20 to 30 tons each), and thoroughly paving the harbor side with large blocks of granite to receive without displacement the water that will be thrown over the wall in great storms.

I think this breakwater should be connected with the headland, and that the United States should purchase so much of the Head as will be necessary for works of defense after the harbor is completed, and for stone-quarries, buildings, &c., for the construction of the breakwater.

The proposed breakwater of 5,000 feet is estimated to cost as follows:

108,333⅓ cubic yards of ashlar masonry, at $18	$1,950,000 00
70,000 cubic yards of rubble masonry, at $9	630,000 00
295,000 cubic yards large stone, at $5	1,475,000 00
2,247,500 cubic yards small stone, at $2	4,495,000 00
Contingencies, 10 per cent	855,000 00
Total	9,405,000 00

A breakwater 2,000 feet long is estimated to cost as follows:

43,333⅓ cubic yards ashlar masonry, at $18	$780,000 00
28,000 cubic yards rubble masonry, at $9	252,000 00
118,000 cubic yards large stone, at $5	590,000 00
747,000 cubic yards small stone, at $2	1,494,000 00
Contingencies, 10 per cent	311,000 00
Total	3,427,000 00

GALES.

The prevailing winds on the coast from November until April are from the south and southwest; in May they veer around to the north and northwest and continue from that direction until about October; the gales most dreaded by mariners are from the southwest, and are at times fearful in their severity; on the whole of this northwest coast between San Francisco and the Strait of Fuca, a distance of 750 miles, there is no harbor that a sailing-vessel will attempt to enter during a heavy southwest gale.

A harbor of refuge is absolutely necessary, and nature seems to have indicated that Port Orford, by its location and natural advantages, should be selected for man to complete, and thus present a safe harbor to which mariners can run for shelter in any gale.

Port Orford is in the collection district of Southern Oregon; it is no longer a port of entry. In the range of hills in rear of the harbor there is said to be an inexhaustible supply of coal, and between the town and the Coquille River there are forests of the best cedar timber.

The nearest port of entry to Port Orford is at Ellensburg at the mouth of Rogue River, about 25 miles south of the harbor. I was unable to learn what, if any, revenue was collected at Ellensburg during the last fiscal year.

The nearest light-house is on Cape Blanco, 7 miles distant, and the nearest works of defense are at the mouth of the Columbia River, about 220 miles distant.

Since completing the foregoing, I have received a very able and interesting communication from Capt. William Tichenor, an experienced sailor and old resident of Port Orford, upon the great stream setting from the Japanese Islands northeast to the northwest coast of America, and its effects and changes on our shore-line in eddies, shoals, drift-sands, &c. Captain Tichenor has gone into the whole subject and gives his opinions as to the effects upon our coast from Cape Mendocino to the Strait of Fuca, and particularly at Port Orford. I quote from the closing portion of his letter as follows:

Port Orford has the following advantages: It is the central point between San Francisco and Puget Sound; it is the most western harbor on the coast, and it is therefore not liable to calms; it is *exempt at all times* from black fogs, and it is very seldom visited by gray or calm fogs; it is the most capacious roadstead upon the coast, and large enough to accommodate our rapidly-growing commerce for all time to come; it is exempt from all sunken dangers, either in it or its approach; it is shielded from all danger of being filled with drifting sands; it has the very best holding-ground of any roadstead upon the coast, composed of sand, loam, and decomposed slate; it affords, immediately at hand, all the material, and of excellent quality, for any improvement desired.