IN THE SENATE OF THE UNITED STATES.

LETTER

FROM

THE SECRETARY OF WAR,

IN RESPONSE TO

A resolution of the Senate February 1, transmitting a report on the improvement of the entrance of Yaquina Bay, Oregon.

FEBRUARY 8, 1892.—Referred to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington, February 3, 1892.

SIR: I have the honor to transmit herewith a letter from the Chief of Engineers, dated the 3d instant, submitting a copy of the report of Maj. G. L. Gillespie, U. S. Engineers, dated December 11, 1880, with accompanying copy of a report of Assistant Engineer J. S. Polhemus, to the Chief of Engineers, on the improvement of the entrance to Yaquina Bay, Oregon, which reports are furnished in response to a resolution of the Senate dated the 1st instant, as follows:

Resolved, That the Secretary of War be, and he is hereby, directed to furnish for the use of the Senate a copy of the report of Maj. G. L. Gillespie, U. S. Engineers, dated December 11, 1880, with the accompanying report of Assistant Engineer J. S. Polhemus, to the Chief of Engineers, on the subject of improving the entrance to Yaquina Bay, Oregon.

Very respectfully,

S. B. ELKINS,
Secretary of War.

The PRESIDENT OF THE SENATE.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 3, 1892.

SIR: I have the honor to acknowledge receipt from the War Department of resolution dated February 1, 1892, of the Senate of the United States directing the Secretary of War "to furnish for the use of the Senate a copy of the report of Maj. G. L. Gillespie, U. S. Engineers, dated December 11, 1880, with the accompanying report of Assistant

Engineer J. S. Polhemus, to the Chief of Engineers, on the subject of mproving the entrance to Yaquina Bay, Oregon."

This resolution was referred to this office for report, and to comply with its requirements, I beg to submit the inclosed copy of report of Lieut. Col. Gillespie mentioned, together with copies of the map, and report of Assistant Engineer Polhemus, which accompanied that report to this office.

The resolution of the Senate is herewith returned.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. S. B. ELKINS,
Secretary of War.

IMPROVEMENT OF YAQUINA BAY, OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, December 11, 1880.

GENERAL: I have the honor to inclose herewith a chart of Yaquina Harbor, Oregon, made under the authority of the Department, dated July 16, 1880, approving the project contained in my letter of June 30, 1880. Accompanying this letter is a report by Mr. J. S. Polhemus, assistaut engineer, detailing the circumstances of the survey and submitting a plan of improvement.

An inspection of the map reveals the following facts in relation to this harbor, viz:

1. The north side is a high and bold bluff of soft sandstone which slopes precipitously to the sea and to the bay. A double ledge of sandstone, visible to low-water mark, breaks out from the sea slope and treuds in a southerly direction across the entrance, with small sunken knobs outcropping at several points along the line.

2. The south side is a low sandspit, which stretches unbroken for a long distance to the southward.

3. The bar is composed of sand, which, like all similar bars on the coast, shifts under the prevailing winds, and has in many places sunken rocks which make the entrance dangerous except at high tide with a smooth sea.

4. Three shoal channels are apparent through the bar, each with about 7 feet at low tide, one on the south side, in extension of the outer reach of the bay, one on the north side, choked with shoal areas, and one intermediate, between the other two.

5. At about one-quarter of a mile seaward of the bar there is a dangerous reef of sunken rocks, extending in a north and south direction, with many small and dangerous channels through it. The reef is 1½ miles long, the water varies in depth over it from 6 to 18 feet at low tide, and the several channels have a width from 60 to 2,000 feet. One mile to the southward there is a shoal upon which the sea breaks heavily.

The water is smoothest on the bar during the summer months, but breaks heavily when winds from the southwest or northwest prevail. The average range of the tides is 6 feet, approximately, and it is not safe for a vessel drawing over 11 feet to attempt the crossing except at high tide with a smooth sea. In heavy weather the seas break heavily over the entire entrance and no vessel should attempt to enter.

The existence of many isolated sunken rocks between the north end

of the outer reef and the shore line makes the entrance at that side a dangerous one at all times. When the seas are westerly, the outer reef acts as a partial protection for the entrance, but, in general, may be regarded as a dangerous obstruction to the approaches to the harbor.

It is thought inadvisable to do anything to this outer reef; its reduction will cost an immense sum, and, once effected, would but slightly ameliorate the difficulties of the entrance.

It is difficult to determine the special improvement which will benefit this harbor. My study of the known facts and conditions, discovered by this and previous surveys, leads me to recommend the protection of the south spit on the inside by mattresses and stone and along the south bank of the outer reach of the channel, if found necessary, and the construction of a short jetty made of cribs filled with stone, at the point shown on the chart, to deflect the ebb currents gently towards the center of the existing bar. At present, the channel shifts through an arc of nearly 120°; the building of the jetty will diminish this arc and will tend to maintain deeper water in a given direction over the bar. The bar broke so heavily during the time of the survey that it was impossible to make any borings to ascertain how close the underlying rock comes to the surface. The existence of the two rocky reefs and the outcropping of isolated rocks between them, and disconnected with them, leave me to infer that rock will be found everywhere at no great depth at the entrance.

This fact would then demand that the direction for the desired channel of permanently deep water should be given by our improvement; if rock is found in position in the channel so directed, at a height dangerous to the navigation of the channel, then it should be removed by blasting to a width and depth which the circumstances of the case may require. It would be useless to do any blasting on the outside until it has been ascertained that the proposed improvement has given a permanent direction to the entrance channel.

The cribs to be used in the construction of the jetty will be of the kind usually adopted for lake-shore improvements, and will rise to the level of mean low tide at the harbor. The beach, from high-water level to low-water level, will be protected on the south or exposed side by sinking gabions in the sand and heaping sand over them, and probably covering the surface with a layer of mattresses and stone, to prevent the winds cutting out the beach on the north side. Below low-water line, to a depth of 5 feet at medium low water, the bottom will be covered with mattresses and stone, with a bottom width of 50 feet, and rising with gentle slopes to low-water level. Beyond the 5-foot curve, the bottom will be covered likewise with mattresses, or a grillage of mattresses, likewise 50 feet wide, properly ballasted, upon which will be sunken cribs of varying height, depending upon the depth of water. They will be 50 feet long by 30 feet wide, will rise to mean low-tide level, and will be heavily riprapped on both sides with stone resting on mattresses. It is proposed to frame the cribs in sufficient numbers, in advance of any construction, to take advantage of all the quiet weather for sinking which may occur, and to have them moved inside the bay where they can be reached readily. If it is found impracticable to sink the cribs in the open sea or to hold them in position after sinking, this plan of construction will be abandoned and the plan proposed by Mr. Polhemus of using mattresses and stone only, will be experimented with. The cribs, by confining the stone, protect the components of the mass from being acted upon, individually, by the waves,

and the cross section of the jetty being much smaller, the expense of construction is proportionally reduced.

The following is the estimate for building the jetty, composed partly of mattresses and stone and partly of cribs filled with stone:

500 feet beach protection, from high-water to low-water line, at $3.50 per foot.	$1,750
400 feet mattresses and stone, from low-water line to 5-foot curve, at $25 per foot	10,000
400 feet cribs filled with stone, from 5-foot curve to 12-foot curve, at $60.	24,000
Estimated total cost of improvement	35,750

The appropriation will build 1,400 feet of cribwork and shore protection, approximately.

Once completed and thoroughly protected, the improvement should remain without further increase for one year, during which period the changes of the channel due to it and the effects of the seas upon it, should be closely watched and the observations carefully studied, to ascertain what modifications or extensions are needed.

If the plans meet the approval of the Department, I would recommend that the work be done by hired labor, after purchasing the necessary materials in the open market. Suitable timber and stone abound on the bay, and can be procured, it is believed, at reasonable rates.

I would also request that the wishes of the Department be communicated to me by telegraph.

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

G. L. GILLESPIE,
Major of Engineers,
Brevet Lieutenant-Colonel, U. S. A.

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

REPORT OF MR. J. S. POLHEMUS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, December 11, 1880.

COLONEL: I have the honor to submit the following report on the survey of the bar and entrance of Yaquina Bay, Oregon, made under your direction in August and September last.

In accordance with your written and verbal instructions, I left Portland, August 12, in the small schooner *Kate and Anna*, and proceeded by sea to Newport, Oregon, on Yaquina Bay, with a portion of my party, where I arrived August 16, and the next day established a tide gauge on the wharf and commenced the erection of beacons for the location of soundings. The schooner *Kate and Anna* was retained for hydrographic work until August 21, on which date the small steamer *Quickstep*, which had been previously engaged in Astoria, arrived, in charge of Capt. Wood, and was subsequently used for all the outside soundings.

My party consisted of Capt. G. W. Wood, assistant, and master of the steamer; Mr. W. H. Burrage, transit man; Mr. J. Dahl, recorder; and the necessary crew of steamer, leadsmen, and boatmen, 12 altogether.

The inside soundings were taken with one of the ordinary fishing boats brought from Astoria.

Part of my letter of instructions read as follows:

"You will commence operations on the bar at the entrance to the Yaquina. You will then go to the Coquille River by any means you can obtain, complete that survey, and on your return examine Siuslaw Harbor, leaving the inside work at Yaquina Bay for the last."

Consequently the beacons and triangulation stations put up were only located approximately at first for the plotting of the work roughly in the field.

On the first day we were able to work on the bar we had the misfortune to have the rudder of the *Quickstep* carried away by a sea, which delayed the outside work for ten days. The time, however, was profitably employed in completing the hydrography of the bay and entrance.

September 1 the steamer was in repair, and by September 9 all the hydrographic work was finished and the party left in the *Quickstep* for the Coquille River.

I returned from the Siuslaw River by land, with Mr. Burrage, October 24, measured a base and the angles of the triangulation, and finished the topography, leaving Yaquina Bay November 5 for Portland.

THE SURVEY.

While sounding the steamer was kept moving in straight lines, wherever it was possible to go, at the rate of 3 or 4 miles an hour, and located every five minutes, or oftener, by two angles simultaneously observed with two sextants, by Capt. Wood and myself.

Soundings were taken to the nearest foot, either every half minute, or as fast as two leadsmen could heave alternately, and have been reduced to the mean of the "lowest low waters."

About 6,000 soundings were taken and 582 sextant locations made.

To ascertain the character of the bottom a strong pole shod with an iron point was used.

This was thrust down on the bar at various points, and the bottom judged of by the shock and by an examination of the point.

TIDE GAUGE.

A tide gauge was set up against the wharf at Newport, and read to the nearest tenth of a foot every hour from August 17 to October 26 (seventy-one days), night and day, and every fifteen minutes while the work was in progress.

The survey extended over at least a mile of the bay and far enough out to sea to embrace the outer reef in front of the bar, but being made with a view to improvement, was more thorough on the bar proper and in the entrance. Thirteen triangulation stations were used, part of which were built up, to be used as signals for locating soundings.

The angles were measured with a very poor Gurley transit, but by repeating were all made to close within one minute.

A base line 2,535 feet long was measured between two of the stations very carefully with a steel tape.

TOPOGRAPHY.

The topography was put in with stadia, by running a shore line between the stations and plotting in the field.

The low-water line as shown on the map is that of the average lowest low water.

To determine the true bearing of one of the sides of the triangulation, three observations were made on Polaris at elongation.

Twenty-four days were consumed altogether in making the survey. In the early part of the work much delay and annoyance was occasioned by fogs, and by the strong prevailing northwest winds of summer; and at the last by rain.

Acknowledgments are due to Capt. G. W. Wood and Mr. W. H. Burrage for their efficient aid on the survey, and to Mr. R. A. Bensell and other citizens for valuable information.

A map of the survey to accompany this report has been carefully made, on a scale of 1:5000, by plotting the main stations by their calculated coördinates.

A tracing enlarged to the same scale, from the United States Coast Survey Chart of 1868, has been prepared for the purpose of showing changes, by the comparison of the curves of equal depth.

The tide record for the month of September has also been plotted.

GENERAL DESCRIPTION.

Yaquina Bay, into which flows the Yaquina River, is situated in Benton County, Oregon. It enters the Pacific Ocean, in latitude 44° 36′, longitude 124° 04′, 4 miles south of Cape Foulweather and 14 miles north of the mouth of the Alsea.

From the entrance it is about 1 mile in width for 2 miles, with the deepest water along the north shore, and large sand flats in the middle.

It narrows as we ascend, to a short distance above Oysterville, 6 miles, where it is 2,000 feet wide; from this point it carries tide water in a river channel, from 800 to 200 feet wide, to Elk, 20 miles from Newport. Several sloughs and creeks enter this portion, which is more of a tidal estuary than a river.

The land on each side, with the exception of a small portion of the south shore near the entrance, which is sandy, and a few flats and tide lands, is very much broken and hilly, covered with burnt timber and fern.

THE ENTRANCE.

The trend of the coast is nearly north and south at the entrance, which, inside the bar, is quite straight, 700 feet wide at low water, with a depth of from 18 to 30 feet, and bears about southwest.

On the north is the rocky headland of Yaquina Head, which rises in a nearly vertical bluff of soft rock and sand, 100 feet above the level of the sea, on which is situated the old light-house.

From this headland a rocky reef extends into the ocean south-southwest towards the bar, marked by two distinct ridges, visible at low water, between which is a covering of sand. One of these ridges, or reefs, extends from high-water mark 2,100 feet, and ends in a small rock, when it appears to sink.

This reef again makes its appearanee 3,500 feet farther on, nearly in the same line, in rocks awash at extreme low water, off the south shore. The rock of which these reefs are composed is a soft grayish or yellowish sandstone. It can be easily cut with a knife or hatchet, and wherever exposed is perforated by a shellfish called the rock oyster. The north beach to the westward of the light-house, as we round the point, is of rock covered above low-water mark, generally with a layer of sand, and extends to Cape Foulweather.

At low-water mark the north boundary of the entrance and channel is of the same kind of rock to Newport and beyond.

The south shore of the entrance and south beach is of sand, which is blown up into a line of irregular shifting dunes a few yards back of high-water line.

This sand beach extends to Seal Rocks 10 miles below.

It probably rests on a foundation of rock near the entrance, as Mr. Bensell states that in a violent southeast storm in 1865 it was swept quite clear of sand in places, and the rock exposed; also, in attempting to raise a wreck on the same beach, they were obliged to carry their blocking down to rock some 10 feet below the surface.

THE BAR.

A bar extends across the entrance, with its crest about half a mile from shore. It has a width between the 3-fathom curves of 1,900 feet; and at the time of the survey three channels existed across it, as shown on the map: One to the north, corresponding somewhat to the north channel shown on the Coast Survey chart of 1868, with 7 feet of water in its shoalest part; another, middle channel, some distance to the south, with 6 feet; and one far to the south along the beach, inside of several rocks, with a depth of seven feet.

The soundings on the bar show sand, with the exception of the reefs and rocks already spoken of; but from the formation of the reefs and rocks lying off the south beach, and the bar itself, it is safe to infer that the bar is composed of sand overlying a reef or reefs of soft rock to an unascertained depth.

The reef is probably broken and full of crevices and holes filled with sand.

The sea breaks quite heavily on the bar in rough weather, although somewhat modified by the reef extending along the coast outside; it usually comes from the westward, but the bar being short has but about three breakers.

CHANGES.

When the survey was made in 1868 the channel was well to the north. Two years afterward Capt. Jessen found it to the south among the rocks, and across the north channel heavy breakers.

When Capt. Wood made the examination in November, 1879, he found the best water through the middle channel (9 feet).

I found the water well divided into three channels. The changes from 1868 to the present time can be seen by comparing the accompanying tracing* of the Coast Survey chart with the chart of this survey.

During the summer months, when the prevailing winds are from the northwest, the ebb current is deflected by their influence and the natural direction of the entrance well to the south, and the south channel opens, with a corresponding shoaling in the north channel.

When winter sets in, however, the storms and general direction of the winds are from the southwest. The south channel is then probably filled with sand, and the ebb flows more directly across the bar through the north and middle channels.

While the survey was in progress the northwest winds blew continuously, and the set of the ebb current at the mid-channel buoy inside the bar was almost south.

APPROACHES.

Outside, half a mile from the bar, extends a rocky reef of broken patches or lumps, with wide gaps between, with from 6 to 18 and 20 feet of water on it at low tide, on which the sea breaks heavily in rough weather and at low water. It runs slightly east of north toward Cape Foulweather, but does not extend more than a

*Not printed.

mile. It offers a slight protection to the bar by breaking the first force of the sea, but only to a limited extent, as it only extends to a point west of the middle channel, and has large deep channels through it.

It is marked by a buoy at its southern extremity, and on it grows much kelp. Between the reef and the bar there is from 4 to 5 fathoms of water.

While at Yaquina I did not observe the sea to break between the south end of the reef and the bar. It breaks heavily, however, on a shoal about 1 mile south of the reef and 1 mile from shore, on which there is 13 feet of water. I did not have an opportunity of observing the sea in rough southerly weather.

The harbor inside is not large, but has from 24 to 30 feet to Newport, with a width of from 600 to 300 feet. From Newport for a mile there is a depth of not less than 18 feet at low water for a width of 300 to 400 feet; it then widens out and shoals to 16 feet, after which it deepens again to 18 and 24 feet, which it carries nearly to Oysterville. The capacity of the harbor can best be judged of by an inspection of the Coast Survey chart.*

I am informed that there is at least 9 feet least depth to Depot Slough, 11 miles, and the river is navigable for light-draft steamboats as far as Elk City, 20 miles from Newport.

Along the south shore of Yaquina Bay there is a narrow channel which has deepened somewhat since 1868, and while the survey was in progress was rapidly washing away the land by the ferry.

The middle channel through the sand flats has filled up during the last few years.

TIDES AND CURRENTS.

The tide rises and falls twice in 24 hours, the tides being unequal in proportion to the moon's declination. The tide, after rising to the lowest of the high waters, falls to the highest of the low waters, then rises again to the highest of the high waters, and falls again to the lowest of the low waters, thus giving the greatest possible discharge over the bar once a day.

The average rise of the highest high tide above the mean of the lowest low waters was found to be 7.7 feet; that of the lowest high tide 6.5 feet.

The highest single tide observed was 10 feet above this level, and the lowest 1.4 below.

The tides are the same at Oysterville, and I am told nearly the same at Elk.

No observations for current velocity were taken. The ebb and flood currents are strongest at half tide, and in the entrance run about 5 miles an hour.

I have seen the buoy opposite the wharf at Newport, and the mid-channel buoy in the entrance drawn entirely under at times by the force of the current.

The area of the bay and river under tidal influence is about $5\frac{1}{10}$ square miles, over which the average rise and fall of the tide is not less than 7 feet; to which must be added the fresh-water flow of the Yaquina River proper, which, however, is a very inconsiderable stream and plays but a small part in the hydraulics of the entrance.

This volume of water flowing out has scoured and at present maintains a channel 800 feet wide and 24 feet deep at low water, at the outlet of the bay inside the bar.

PLAN FOR IMPROVEMENT.

The bar being of sand resting on a foundation of rock at an uncertain depth below, any plan for its improvement will have to embrace two problems.

1. To confine the ebb current over the bar to one channel of a sufficiently contracted width to enable it to scour out and maintain such depth as the tidal flow will admit of, provided nothing is met with but the overlying shifting sand.

2. In case the sand is swept off and the rock exposed before a sufficient depth has been secured to blast out and remove this rock. Before uncovering the rock by an increase of the current at some suitable place on the bar, it would be useless to attempt to remove it, for it would be almost impossible to blast, covered as it is with sand, and what holes were blown out would soon fill with the shifting sand.

To keep all the outgoing water in one channel it would be necessary to build at least one jetty running from shore, the most suitable location for which seems to be from the south beach to or toward a point on the shoal immediately to the south of the middle channel, where at the time of the survey there was but 2 or 3 feet of water at low tide, and where Capt. Wood, from his examination, reports rocks.

Such jetty would force most of the water out between itself and the rocky reef extending from Yaquina Head, over a space 1,800 feet wide, covering the present north and middle channels, which are well situated for entering the harbor at high tide.

This will either give a much increased depth over the bar or scour off the overlying sand, and show where special removal of rocky obstructions will be necessary.

*Not printed.

The rocky reef to the north would act as a barrier to the water in that direction, and should the middle channel be chosen for final improvement, could be extended artificially, if necessary, thus still further strengthening the current.

The total length of the proposed jetty from low-water line to the crest of the bar would be half a mile, and the greatest depth on the proposed line is at present 11 feet at low water. The bottom is sand, with rock probably not more than 20 feet underneath. It being inside the bar, would not be subject to the heaviest seas, except at its extremity.

At low water the sea is very light inside the bar, but at high tide and in rough weather its force is considerable.

The outer end, it is probable, would have a foundation of rock to quite near the water surface.

Although we must freely admit it impossible to state with mathematical certainty the depth which would follow on the bar should the proposed jetty be completed to its crest, still, judging from the present depth maintained on the inside, it would not seem unreasonable to expect from 12 to 18 feet at low water on the bar, provided rocks do not interfere.

Probably long before the jetty reaches the bar its influence would be such that the deepest place over the rock could be ascertained, and its direction slightly altered accordingly. Sand would accumulate to the south of the jetty, but should the north jetty finally be built, it does not seem likely that much, if any, bar would form in front. The littoral currents which always exist would tend to carry the sand to one side and the waves to wash it shoreward.

It might be necessary to protect the south shore of the entrance from further washing away.

Any structure built out into the sea from a coast on which such heavy seas break must necessarily have great resistance to be permanent, and will be expensive.

For the construction of the greater part of the jetty, especially the outer half, it is probable that heavy pieces of rough quarry stone, or concrete blocks from 2 to 10 tons in weight will be required, either thrown into the sea directly on the natural bottom or upon a foundation mattress.

The inner end for 500 or 600 feet might be made of brush mattresses sunk and covered with stone; back of this part it is thought sand would rapidly accumulate and protect in a measure the brush mattresses.

The strength of the jetty could be regulated by the size of the stone or blocks of concrete used as might be found necessary by experience as the work advanced.

The objections to cribs are they would be subject to the ravages of the teredo and only last a few years; on the other hand they enable the plan to be tested speedily, and if the results are satisfactory may be made the nucleus of a permanent work.

Their adoption will be dependent upon the difficulties encountered in sinking them, and will be a matter of experiment.

Plenty of good brush is to be found on the Yaquina River, and sandstone of a fair quality with a specific gravity of 2¼.

The latter can be found in a hill at the river's edge 12 miles above.

A sawmill is in operation 4 miles from Newport with capacity sufficient to furnish the required timber for construction.

The following estimates are made for the south jetty, 2,500 feet long, with an average height of 12 feet from the bottom to 2 feet above low water.

South jetty:	
500 feet of brush and stone jetty, at $90 per linear foot	$45,000
2,000 feet of stone jetty on a mattress foundation, 20 feet wide on top with side slopes of 1 on 2, at $160 per linear foot	320,000
North jetty:	
This is of similar construction to the south jetty, except that the artificial mattress foundation is omitted and the average depth is less.	
1,000 feet, at $100 per linear foot	100,000
Total	465,000

No estimate has been made for blasting out the rock, as the amount which might have to be removed is so very uncertain. It is a soft rock, however, and could be easily blasted.

Very respectfully, your obedient servant,

J. S. POLHEMUS,
Assistant Engineer.

Col. G. L. GILLESPIE
Major of Engineers, Bvt. Lieut. Col., U. S. A.