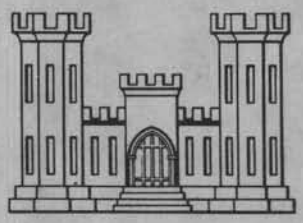
CORPS OF ENGINEERS
U. S. ARMY

REVIEW REPORT

on

TILLAMOOK BAY AND BAR, OREGON

April 16, 1953
(Revised December 18, 1953)



OFFICE OF THE DISTRICT ENGINEER
PORTLAND, OREGON

REVIEW REPORT

on

TILLAMOOK BAY AND BAR, OREGON

Prepared by
PORTLAND DISTRICT, CORPS OF ENGINEERS
dated April 16, 1953
(revised December 18, 1953)

S Y L L A B U S

In view of the considerable benefits that would accrue to the public and to local interests from closure of the breach in Bayocean Peninsula, including preservation of existing navigation facilities, savings in future maintenance costs, protection of remaining oyster beds and agricultural lands, and general benefits to the community, the district engineer is of the opinion that construction of a closing structure is amply justified. The estimated total cost of construction work proposed is $1,750,000. The ratio of annual benefits to annual costs is 2.52 to 1. Substantial local cooperation, including a cash contribution of not to exceed $250,000, is an essential requirement.

TILLAMOOK BAY AND BAR, OREGON
REVIEW REPORT

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CORPS OF ENGINEERS, U. S. ARMY
Office of the District Engineer
Portland, Oregon District
628 Pittock Block
Portland 5, Oregon

NPPGP-7

April 16, 1953
(revised December 18, 1953)

SUBJECT: Review Report on Tillamook Bay and Bar, Oregon

TO: Division Engineer
North Pacific Division
Corps of Engineers
500 Pittock Block
Portland 5, Oregon

1. Authority. - This report is submitted in compliance with a resolution of the Committee on Public Works of the United States Senate adopted June 20, 1952, which reads as follows:

> "Resolved by the Committee on Public Works of the United States Senate, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the report of the Chief of Engineers on Tillamook Bay and Bar, Oregon, published as House Document Numbered 650, Eightieth Congress, and other reports, with a view to determining whether the existing project should be modified in any way at the present time, with particular reference to the improvement, preservation, and protection of existing navigation improvements and other economic assets of the Tillamook Bay area."

2. Reports under review. - The latest report on Tillamook Bay and Bar, which included consideration of the erosion of Bayocean Peninsula in addition to navigation, was submitted to Congress May 3, 1948, and published as House Document No. 650, Eightieth Congress, second session. It was favorable only to the provision of a small-boat basin at Garibaldi and approach thereto. Further improvement of other navigation features, and protection of Bayocean Peninsula from erosion were found to be not justified. Prior to 1948, 13 reports on Tillamook Bay were submitted to Congress, the first dating back to 1888. Two of the reports concern erosion of Bayocean Peninsula. One was a comprehensive report entitled "Report on Beach Erosion Studies, Tillamook Bay, Oregon, with Reference to Bayocean," prepared in collaboration with and submitted to the Shore Protection Board by the district engineer August 26, 1940, and the other was the Shore Protection Board's report dated December 17, 1940, entitled "Report on Tillamook Bay, Oregon, with a View to Protection of Bayocean and Property Thereon from Erosion and Storms." The Shore Protection Board in its report concluded that, at that time, the cost of any plan of construction that would provide protection to Bayocean Peninsula would be many times the benefits to be derived therefrom, and that there were no Federal interests involved in the protection of that peninsula against erosion.

3. Scope of survey and report. - The survey covered by this report includes studies of (1) the extent to which continued breaching of the Bayocean Peninsula by wave and wind action constitutes a threat to navigation of the bay, its tidal tributaries, and entrance; (2) the best and most practical plan to abate or arrest the damages now occurring during storm periods and which will increase as the open gap near the heel of the peninsula widens and deepens; (3) the value of local and ocean navigation to the area; (4) present and prospective losses suffered by the oyster industry; (5) threatened damages to agriculture from overtopping and erosion of dikes by waves and ground swell direct from the ocean because of the removal of the former natural protection of Bayocean Peninsula; and (6) the problem involved in protecting the remaining lands of Bayocean Peninsula from further inroads of the sea.

4. Description. - The entrance to Tillamook Bay, at latitude 45°34' N., is 47 statute miles south of the mouth of Columbia River. The entrance has been improved by the construction of a north jetty extending 5,700 feet seaward from the coast line, as shown on the accompanying map. Prior to the break in Bayocean Peninsula, the width of the entrance, between low-water lines, remained fairly constant at about 1,300 feet. Tidal range at the entrance, from mean lower low to mean higher high water, is 7½ feet, and the extreme range is about 13½ feet. The entrance is protected from northwesterly storms by the north jetty, but is fully exposed to winter storms from the south and west. Controlling depth over the ocean bar, as shown by the survey of June 1950, is about 16 feet. In the past, dredging on the ocean bar has been necessary only at intervals of several years inasmuch as the project depth of 18 feet has been quite well maintained by the natural scouring action of the ebb tides, aided by the north jetty.

5. Tillamook Bay is 6 miles long, north and south, and has a maximum width of about 3 miles. Its areas at high and low waters are about 14 and 7-3/4 square miles, respectively. Between mean higher high and mean lower low water the tidal prism contains approximately 58,000 acre-feet. From the entrance to Miami Cove, 3 miles inside the outer end of the jetty, the controlling depth is about 12 feet in the vicinity of Garibaldi (survey of March 1953).

6. From Miami Cove, an interior bay channel extends southerly, past Bay City to the mouth of Tillamook River, a distance of about 6 miles. This channel is used principally by tugs towing log rafts from the booming grounds in Tillamook River to the mill center at Garibaldi, and also by commercial fishing boats and oyster boats. Natural depths in this channel have, in the past, been adequate to accommodate the traffic using this waterway. The controlling depth in the bay channel is 0 feet at mean lower low water (survey of March 1953).

7. Five rivers, Miami, Kilchis, Wilson, Trask, and Tillamook, with combined drainage areas of 574 square miles, drain into the bay. All of these rivers head in the Coast Range and flow through narrow canyons in the upper reaches. At the lower elevations, the canyons gradually widen into valleys near Tillamook Bay. The valleys of the Kilchis, Wilson, Trask, and Tillamook Rivers merge to form the broad alluvial plain in the center of which is located the city of Tillamook, Oreg. Miami River enters Tillamook Bay on the northeasterly side, 5 miles north of the mouth of Kilchis River. The lower 4 miles of Tillamook River are used extensively for storage and rafting of logs. Hoquarten Slough, which connects with Tillamook River and is the only navigable waterway entering the city of Tillamook, has a controlling depth of about 3 feet at mean lower low water. Miami, Kilchis, Wilson, and Trask Rivers are navigable by light-draft boats to the head of tidewater, but are not important as carriers of commercial traffic.

8. Prior to November 1952, Tillamook Bay was connected to the Pacific Ocean only by the navigation channel around the north end of Bayocean Peninsula. The peninsula, a natural barrier about 4 miles in length, varied in width between high-water lines from 300 feet near the southerly end to 3,300 feet at a point 1 mile from the northerly end. Elevations varied from 17 feet above mean lower low water, on a sand, gravel, and boulder formation at the south end, to 140 feet on the highest dunes located near the middle of the peninsula. The northerly portion of the peninsula consists of a sandy barrier beach nearly 1 mile long, with an average elevation of 15 feet and with occasional dunes rising to elevations of nearly 60 feet. That part of the peninsula from Bayocean to the northerly tip, known as Kincheloe Point, is almost entirely covered with a growth of salal brush and spruce trees. The southern 1½ miles of the peninsula formerly consisted of a continuous sand ridge of relatively uniform elevation except for three low gaps. These gaps, known as Southern, Jackson, and Natatorium Gaps, were located at the southerly end of the peninsula, near the center of the narrow spit and just south of the town of Bayocean. The gaps had lengths, between high-water lines on the ocean and bay sides, of approximately 300, 400, and 1,200 feet, respectively. The ocean sides of the gaps were somewhat protected by a natural, wave-formed, boulder barrier-bar, over which waves washed only during severe storms at the time of high tides. The bay side of the gaps conformed with the prevailing elevation along the entire bay side of the peninsula, being only slightly above the elevation of extreme high tides in the bay.

9. During the month of November 1952, severe storm waves, in combination with higher than ordinary tides, breached the narrow portion of the peninsula. Within a short time, the width of the break increased to nearly 3,000 feet, measured along the ocean front. The deepest cut was near the former location of Jackson Gap. Succeeding high tides and continuing storm conditions during the last half of November, and at frequent intervals during December, continued to widen the newly created entrance to nearly a mile. Several houses were undermined and washed to sea.

10. The latest survey of the area, made in the period from January 13 to February 16, 1953, showed a narrow ridge, approximately 4,000 feet long, extending northeasterly from the original root of the peninsula, thence bayward, in a one-quarter bend, as shown on the accompanying map. This ridge is composed of sand and gravel, and had a maximum height above mean lower low water of about 15 feet. Another ridge, about 1,500 feet long and with a maximum height of about 10 feet, but with a broader base, extended southeasterly from a point on the southern tip of the present island for about 1,400 feet south of Natatorium Gap. This ridge also is composed of sand and gravel. A broad, low-lying sand and gravel island, most of which was covered at high tide, was located approximately midway between the ends of the aforementioned ridges. The two main washes of the "break" in Bayocean Peninsula are located north and south of this island. The northerly channel had a maximum depth, at one point only, of 10.7 feet below mean lower low water. However, at no point through the break did the low-water contour extend from the ocean to the bay (see accompanying drawing). Since the survey of January-February 1953, visual inspections have revealed that the two ridges now extend considerable additional distances to the east. The southerly ridge now extends easterly to a point almost due north of Pitcher Point but has decreased in height. The northerly ridge has extended easterly a lesser distance and has increased in height. The island near the center of the break has been smoothed off to the point where it is completely submerged at half-tide level.

11. The nearest improved deep-draft harbors are located at Newport, Oreg., 66 miles south, and the mouth of Columbia River, 47 miles to the north. At Newport, the entrance to Yaquina Bay has been improved by twin jetties, the project providing for a depth of 26 feet across the entrance bar, and channels 20 and 18 feet deep in the harbor. At the mouth of Columbia River, the project provides for a channel 40 feet deep and not less than ½ mile wide between north and south jetties. The project for Columbia River from the entrance to Portland, Oreg., a distance of about 113 statute miles, provides for a depth of 35 feet. Nearby shallow-draft harbors are located at Depoe Bay, 53 miles south, and at the entrance to Nehalem Bay, 7 miles to the north. At Depoe Bay, a fish-boat and resort harbor with a depth of 8 feet has recently been enlarged to 350 feet by 750 feet. An 8-foot entrance channel through a narrow rocky gorge is protected by a short diagonal breakwater located on a rock rim at the north side of the mouth. At Nehalem Bay, an entrance channel 8 feet deep and of no specified width has been secured by means of twin rubble-mound jetties.

12. Diked lands. - At the southeast end of Tillamook Bay, the merging valleys of the Kilchis, Wilson, Trask, and Tillamook Rivers form a broad alluvial plain on which is located the heaviest concentration of large dairy farms within Tillamook County. The lower portion of the plain, nearest the bay, contains a network of waterways formed by the river channels and by numerous branching sloughs. Within this portion of the plain, five organized drainage districts cover a total area of 2,754 acres. Considerable bank protection and levee construction has been done within this area by private interests, county forces, and by relief agencies. Data concerning organized drainage districts are shown in the following tabulation.

Name	Location	Area - (acre)
Stillwell Drainage District[1]	Tide lands between Trask and Tillamook Rivers	412
Dougherty Slough Drainage District	Wilson River	940
Tillamook Drainage District	Trask River	700
Trask Drainage District	Trask River	242
South Prairie Drainage District	Tillamook River	460
Total		2,754

1 Primarily a diking district.

13. The above drainage districts have constructed approximately 23 miles of levees along the tidal portions of the rivers and sloughs. The levees, which vary in height from 6.8 to 9.6 feet above mean sea level and protect about 2,000 acres of low lands against ordinary tidal overflow, are inadequate to afford protection against exceptionally high tides, river freshets, or a combination thereof. Damage to lands because of overflowing of river waters, though of moment in some cases, is generally less important than that caused by salt water inundation. Such damages result from admission of sea water through breaks caused by the erosive action of waves and currents as well as from overtopping tides. Ranchers have stated that the overflow which occurs during freshets does little harm inasmuch as the salinity of the water at such times is negligible. On the other hand, overflow by high tides when there is little fresh water in the streams damages the pasture grass, making it necessary, in some cases, to plow the land and reseed. During periods of submergence and restoration of pasture lands, it is sometimes necessary to import hay and grain for stock feed at considerable extra cost.

14. In a survey for flood control of the Tillamook Bay region, under date of June 20, 1939, it was stated that the improvements in the tideland areas at that time, which were in about the same condition then as now, were serving the needs of the dairy farmers reasonably well. Some damage occurred each year as a result of overtopping of levees by freshets, erosion of river banks during falling stages after river floods, and by occasional overtopping of levees as a result of extreme high tides. That survey considered that damages because of fresh-water overflow could not be prevented at any reasonable cost, either by means of upstream storage or by raising the existing levees. The survey also considered that the cost of improvements sufficient to give complete protection against tidal overflow could not be justified in the light of the then-present land use and revenues derived therefrom. As much of the area devoted to pasture land for dairy herds was reclaimed swamp land or land formerly covered by the tides, and as the drainage of low lands was not considered to be a function of the Federal Government as related to flood control, the report recommended that no work in the Tillamook Bay region be undertaken by the United States at that time.

15. A recent inspection of the levees reveals that several sections are so worn down by cattle or rain erosion that no freeboard remains during winter floods. The levee along the right bank of Tillamook River in the Stillwell District appears to be in the most critical condition. The combination of wave action by river traffic and storms has caused such severe erosion that several sections of levee are in imminent danger of failure. Several sections of other levees throughout the area are very thin or so covered by brush and berries and infested by muskrat and beavers that major reconstruction would be necessary to provide an adequate levee.

16. Precipitation. - Average annual precipitation at Tillamook, as obtained from Weather Bureau records for the periods 1889-1929 and 1933-1951, is about 93.5 inches. Precipitation records were maintained at Glenora, in the Coast Range near the headwaters of Wilson River, during the period 1892-1918, and at McNamers Ranch, approximately 5 miles further upstream, during the period 1937-1941. These stations indicate an average of about 130 inches annually near the summit of the Coast Range. The distribution of precipitation throughout the year at Tillamook is shown in the following tabulation.

Month	Inches (average)
January	13.48
February	11.59
March	10.74
April	6.36
May	5.17
June	3.16
July	1.33
August	1.48
September	4.18
October	7.28
November	13.51
December	15.22
Average annual	93.50

17. Floods. - Authentic records of past floods in the Tillamook Bay region are not available. The flood of December 1933, resulting from a 6-day period of intensive rainfall accompanied by higher than normal tides, is the one most vivid in the minds of local residents. During the 6-day period December 17 through 22, 1933, 16.58 inches of rain fell at Tillamook, an average of 2.76 inches per day. The maximum rainfall in any one day during that period was 3.88 inches. The 1933 flood inundated nearly 10,000 acres of river bottom and low-lying tide lands adjacent to the bay. Extreme flood conditions in this region are not due to flashy, periodic storms of unusual proportions, but are occasioned by intensive rainfall for periods of several days over areas already saturated or covered with snow. Snowfall is rare along the coast but quite common at the sources of the streams in the Coast Range. Precipitation records at Tillamook over the period of record indicate that similar floods probably occurred in 1897 and 1914. This indicates a probable major flood frequency of about once in 17 or 18 years. Lesser floods of damaging nature are frequent, sometimes occurring several times in a single year.

18. Run-off. - Since July 1931, the United States Geological Survey has maintained continuous records of discharges in the Wilson and Trask Rivers, the larger of the five rivers which empty into Tillamook Bay. No other records of run-off are available. Pertinent data from the above-mentioned records are summarized in the following tabulation.

Item	Date	River	
		Wilson	Trask
Total drainage area of river, square miles	--	208	180
Drainage area above stream gaging station	--	162	152
Maximum daily discharge, second-feet	Dec. 22, 1933	27,500	18,600
Minimum observed discharge, second-feet	Sept. 10-12, 1944	55	58
Average discharge (1931-1949), second-feet	--	1,189	966
Estimated peak discharge, second-feet	Dec. 21, 1933	30,000	20,000

19. Tide planes. - During the year 1933, the United States Coast and Geodetic Survey installed automatic recording gages at three points on Tillamook Bay, namely: Barview; Garibaldi; and Tillamook, on Hoaquarten Slough. From the records obtained, the elevations of tide planes were determined. The plane of reference in general use of hydrographic work along the Pacific Coast is mean lower low water, as determined locally at the different tide stations. Substituting the sea level datum of 1929 as the plane of reference, tide plane elevations at the three locations prior to the break in Bayocean Peninsula were as shown in the following tabulation.

Tide plane	Barview (mile 0.0)	Garibaldi (mile 1.5)	Tillamook - Hoquarten Slough (mile 10.0)
Period of observation	July-Nov. 1933	May 1933 - April 1934	Sept.-Nov. 1933
Highest tide (estimated)	+7.0	+7.2	+9.3
Mean higher high water	+3.47	+3.56	+3.86
Mean high water	+2.77	+2.86	+3.16
Half-tide level	-0.08	+0.06	+0.56
Mean low water	-2.93	-2.74	-2.04
Mean lower low water	-4.03	-3.84	-2.74
Lowest tide (estimated)	-7.0	-7.3	-5.7

20. An inspection of the above tabulation shows that at mean higher high water, the plane of most interest to local residents from the standpoint of overtopping existing levees, the difference in elevations at Barview and Tillamook was approximately 0.4 of a foot in a distance of about 10 miles. Lower tide planes increase in slope to a maximum of approximately 1.3 feet for mean lower low water. As shown in United States Department of Commerce publications, the difference in time of high tide, between Barview and Tillamook, was 1 hour.

21. Subsequent to the break in Bayocean Peninsula, staff gages were installed at various points on Tillamook Bay, Tillamook River, and Wilson River. Simultaneous readings were taken over two high-tide periods, December 31, 1952, and January 28, 1953. Although no conclusive results can be obtained from such a short record, the results indicate that the previous slope during higher high water no longer exists and that the difference in time of high water, between Barview and Tillamook, is now considerably less than 1 hour.

22. In the opinion of several residents along the bay, the break in Bayocean Peninsula has resulted in greater tidal action, particularly during southerly and westerly storms. Informal statements would indicate the increase to range from about 1.5 or 2 feet near Bay City to 1 foot or more at the Tillamook River bridge. This is understandable in view of the loss of protection against wind and wave action formerly afforded by the peninsula. During high tide, waves roll through the break, enter the bay, and spread out in a fan-shaped pattern. This action produces a surge effect which is quite noticeable at both the north and south ends of the bay. Operators of the log-booming ground at Garibaldi have stated that several log rafts were broken up during the winter of 1952-1953 as a result of surge action.

23. Tributary area. - The area tributary to Tillamook Bay as a manufacturing center for forest and dairy products, and to the city of Tillamook as a trading center, comprises, roughly, the county of Tillamook. However, on the north, east, and south margins, where topography, roads, and timber ownership favor other centers, indeterminate small areas are tributary to those centers. The county is about 50 miles in length, north and south, and from 10 to 30 miles in width, east and west. Its area is 1,115 square miles, of which 12.1 percent (135 square miles) is classed as farm land and 86.8 percent (968 square miles) is classed as forest-type land. Towns, resort areas, small dunes, and tide flats occupy the remaining 1.1 percent or 12 square miles.

24. Population. - Statistics for Tillamook County and its incorporated towns, published by the Bureau of the Census in 1950, are as follow:

Area	1950	1940	1930
Tillamook County	18,606	12,263	11,824
Tillamook (city)	3,685	2,751	2,549
Bay City	761	379	427
Manzanita	339	--	--
Nehalem	270	247	245
Rockaway	1,027	--	--
Wheeler	291	259	280
Garibaldi	1,249	--	--
Garibaldi precincts (includes Garibaldi city)	1,534	932	1,256

There are three public port districts in the county, the port of Bay City, the port of Bayocean, and the port of Nehalem.

25. Resources. - Resources of the area consist chiefly of forests, agricultural lands, fisheries, and recreational areas, briefly described in the following paragraphs.

26. Forest resources. - The Forest and Range Experiment Station of the United States Department of Agriculture estimates the standing green saw timber in Tillamook County to be about 5.2 billion feet, log scale, of soft woods and 161 million feet of hard woods. In addition, more than 4 billion feet of fire-killed timber in good state of preservation remain to be salvaged from areas burned over by the disastrous fires that swept through the county in 1933, 1939, and 1945. Current annual growth was estimated at 90 million feet by the Experiment Station in 1943, while the full potential induced by natural and artificial restocking was placed at 300 million feet. Since those estimates were made, the Experiment Station has made basic changes in formula for computing growth and now states, informally, the annual increment will substantially exceed 90 million feet. In southwestern Oregon, annual incremental growth was increased 38 percent under the revised method. In the three stated years in which devastating fires occurred, timber was killed as shown below:

Year	Area burned over, acres	Saw and pulp timber killed, board feet
1933	239,695	11,828,712,000
1939	50,091	834,220,000
1945	65,150	439,985,000
Total	354,936	13,102,917,000

(Source: State Forestry Department, Salem, Oreg.)

The greater part of the fire-killed timber has suffered relatively little deterioration, and it is estimated now that, including the 4 billion feet remaining, recovery will amount to approximately 14 billion feet. The State Forestry Department inaugurated and is executing an intensive rehabilitation program whereby the burned-over areas will be replanted and reseeded. At this time, reforestation is about 34 percent complete. Included in the volume of standing saw-timber is a stand of about $1\frac{1}{4}$ billion feet in the Siuslaw National Forest and other Federally-owned tracts. It consists largely of second-growth trees which will be marketable on a sustained-yield basis when salvable fire-killed logs of the burned area are used up, and will contribute a substantial supply of logs to the Tillamook mills.

27. Agricultural lands. - Farm lands comprise 12.1 percent of the county area (86,500 acres). These lands, particularly along the lower reaches of the seven rivers that drain the west slope of the Coast Range in Tillamook County, are devoted largely to dairy farming. Two-thirds of the 936 farms in the county are classed as dairy farms.

28. Fisheries. - Fishing banks off the Tillamook coast are extensive and densely populated, but certain factors, including a rough bar and entrance and lack of a commodious protected harbor within the bay, have discouraged larger offshore fishing craft from basing at and working out of Tillamook. The existing navigation project for Tillamook Bay provides for dredging a small-boat basin and approach at Garibaldi. Funds have not yet been appropriated for this work. Completion of the small-boat basin would provide a protected harbor for small boats and would encourage the use of the bay as a base for fishing craft. During the last 5 years, about 300 tons of crabs and 370 tons of fish have been taken annually off Tillamook and brought into the bay.

29. Recreational areas. - Tillamook County beaches are among the most popular in the State, not only because of their natural advantages but because all are less than 100 miles from the concentration of population in and around Portland.

30. Industries and production. - Conversion of forest resources into finished or semifinished commodities is the principal industry of the Tillamook area. Lumber production in the county in recent years was as follows:

Year	Feet, board measure	Number of mills
1951	237,831,000	23
1950	154,689,000	16
1949	160,418,000	16
1948	142,107,000	19
1947	100,667,000	17
1946	68,508,000	15
1945	28,345,000	8
1944	35,854,000	10
1943	33,163,000	6

(Source: West Coast Lumbermen's Association.)

Eight of the largest mills in the immediate vicinity of Tillamook Bay produced about 225 million board feet of lumber in 1952, creating some $16 million in value of lumber and $7 million in pay rolls for that year. In addition, there are two shingle mills, a plywood plant, a green veneer plant, a hardwood mill, and two remanufacturing plants. Consumption of logs in these operations was about 250 million feet, log scale. Production of logs in Tillamook County increased nearly 200 percent from 1945 to 1951, as is shown by the following:

Year	Feet, log scale
1951	572,155,000
1950	515,438,000
1949	461,782,000
1948	520,373,000
1947	419,778,000
1946	303,926,000
1945	197,235,000

(Source: U. S. Forest Service, Pacific Northwest Forest and Range Experiment Station.)

It is not expected the same rate of increase will continue, but it is believed that production of logs for processing in Tillamook Bay mills will be maintained at somewhere near the current volume for an indefinite period. A systematic program of reseeding and replanting the burned-over areas has been carried on by the State of Oregon's Forestry Department for several years and is scheduled for completion in 1964. The program is stated to be about 34 percent completed at this time. From 1935 through 1950, all forest products

except logs were distributed by rail or truck. In 1951, lumber shipped by ocean carrier amounted to 14,799 tons, and in 1952 the amount was 22,695 tons, or an average of 19,000 tons, all in barges or light-draft ships. The movement by ship is suspended, however, during stormy winter months because of the stand-by expense awaiting safe sailing conditions through the entrance. Of the logs produced in Tillamook County in 1950-51-52, a total of 336,270 tons were transported by ocean barge to Columbia River ports and Grays Harbor, Wash.; an average of 30 million feet, or 112,090 tons per year. In addition, an indeterminate but substantial volume of logs produced within the county moves by truck and rail to milling points outside the county. It is believed that this movement, which in past years has amounted to considerably more than half the total volume, will drop rapidly in proportion to the total. Salvage of logs by private owners has been carried on as rapidly as possible while prices of forest products were high and logs in demand by interior mills. Now, the greater part of the remaining salvable logs and growing timber is in State ownership. The Oregon State Legislature recently enacted a law granting State and county authorities discretionary powers in executing contracts of sale, with reference to the area where logs and timber sold will be milled. Also a new plywood plant is now under construction at Tillamook, creating an additional market for both high- and low-grade logs in that area.

31. Agricultural industry. - Dairy farming is, by far, the chief agricultural activity of the county. Production of milk in 1951 amounted to 56,000 tons, valued at $5,750,000 at farm level. The greater part of the milk produced was used in the manufacture of the famous Tillamook cheese of which nearly 5,000 tons, valued at over $5,000,000, were produced. The industry, which is headed by the Tillamook County Creamery Association, a cooperative consisting of 11 member associations located in various parts of the county, has been strongly and efficiently organized for many years. The association functions as the selling organization and sets high standards for inspection and control of product quality. Direct annual pay roll for handling and manufacture is about $750,000.

32. Oyster industry. - Growing of oysters within the bay constitutes an item of importance in the economy of the Tillamook Bay area. The value of the oyster industry in Tillamook Bay has been estimated by local interests at approximately $2,500,000. About 1,000 acres or one-third of the oyster beds, together with oysters in place, have been destroyed by sand, gravel, and boulders swept into the bay by attrition of Bayocean Peninsula, but the remaining 2,000 acres still are in production at this time.

33. Transportation. - The Tillamook Bay area is served by a branch line of the Southern Pacific Co., giving direct rail connection, for freight only, with the main line in the Willamette Valley and at Portland. The rail line from Portland and Willamette Valley, after crossing the Coast Range, descends the canyons of Salmonberry and Nehalem Rivers to Nehalem Bay, follows the ocean shore to the Tillamook Bay entrance, and follows the inner bay shore to the city of Tillamook after passing through Garibaldi and Bay City. Rail distance, Portland to Tillamook, is 120 miles. Highway U. S. No. 101 is the principal north-south trunk highway. It is intersected in the southern section of the area by State Highway No. 14; at Tillamook City by State Highway No. 6; in the north end by State Highways Nos. 2 and 53. All of the intersecting routes give more or less direct access to Willamette Valley and Portland. Water commerce on the bay is handled by towboat operators or private craft. Tillamook Bay is not listed as a port of call by any of the coastwise shipping lines. Lumber is moved by mill-owned carriers, however, to other Pacific Coast ports. Tillamook Bay ports of Tillamook, Bay City, and Garibaldi are listed in barge line tariffs, and service is rendered for both logs and lumber.

34. Bridges. - There are no bridges across Tillamook Bay. Bridges across tributary navigable waterways are shown in the following tabulation.

Stream	Miles above mouth	Clearance: Vertical at mean lower low water	Clearance: Horizontal	Type	Ownership	Date completed	Permit
Hoquarten Slough	2.5	12.0	30	Fixed, highway	State of Oregon	1931	Yes
Hoquarten Slough	2.55	15.0	40	Bascule, highway	City of Tillamook	1916	Yes
Kilchis River	1.0	21.5	108	Fixed, railroad	Southern Pacific Co.	1	No
Kilchis River	1.5	19.3	75	Fixed, highway	State of Oregon	1	No
Miami River	0.2	14.5	133	Fixed, railroad	Southern Pacific Co.	1	No
Miami River	0.3	14.3	95	Fixed, highway	State of Oregon	1927	Yes
Tillamook River	0.5	24.0	70	Swing, highway	Tillamook County	1928	Yes
Tillamook River	3.5	19.5	95	Fixed, highway	Tillamook County	1931	Yes
Trask River	1.0	14.5	85	Fixed, highway	State of Oregon	1	No
Wilson River	1.5	22.0	115	Fixed, highway	State of Oregon	1931	Yes
Wilson River	2.2	24.6	155	Fixed, railroad	Southern Pacific Co.	1	No

1 Unknown.

35. Prior reports. - Reports on the subject under review which have been submitted in recent years are listed in the following tabulation.

Date of report	Scope	Subject	Recommendation
Jan. 3, 1936	Survey	Improvement for navigation.	Unfavorable
Jan. 10, 1939	Preliminary examination	Protection of Bayocean	Survey recommended in collaboration with Shore Protection Board.
Aug. 26, 1940	Beach erosion study	Tillamook Bay, Oreg., with reference to Bayocean.	Report submitted to Shore Protection Board.
Dec. 17, 1940	Shore Protection Board report	Tillamook Bay, Oreg., with a view to protection of Bayocean and property thereon from erosion and storms.	Unfavorable because cost of adequate protection would be many times the benefits to be derived.
Mar. 15, 1941	Survey	Tillamook Bay, Oreg., with a view to protection of Bayocean and property thereon from erosion and storms.	Unfavorable
Dec. 2, 1946 (House Document No. 650, Eightieth Congress, second session)	Survey	Tillamook Bay and Bar, in the interest of navigation; also with a view to protecting the harbor against filling by the ocean encroaching across Bayocean Peninsula, and isolating the peninsula.	Favorable to dredging a small-boat basin and approach at Garibaldi.

36. Existing Corps of Engineers project. - The existing navigation project, as last modified by the River and Harbor Act of June 30, 1948, provides for a jetty about 5,700 feet long on the north side of the entrance; for a channel through the bar 18 feet deep and of such width as can be practically and economically obtained; for a channel 200 feet wide and 18 feet deep from deep water in the bay to Miami Cove; for initial dredging of a small-boat basin and an approach thereto at Garibaldi, Oreg., both to a depth of 12 feet; for a channel to Hobsonville, 200 feet wide and 16 feet deep, with a turning basin 500 feet wide at Hobsonville, and regulating works as needed.

37. The navigation project is 74 percent complete. Work remaining to be done, as presently authorized, consists of dredging the Hobsonville Channel and turning basin, and the small-boat basin and connecting channel at Garibaldi. Total Federal cost of the project to and including Fiscal Year 1952, is $574,447 for new work and $950,950 for maintenance. In addition, local interests contributed $398,833, in cash and useful work performed, for new work on the north jetty and $6,450 for constructing a channel between Bay City and Tillamook. The latest (1952) approved estimate for annual cost of maintenance is $28,000 for entrance and bay channels.

38. The River and Harbor Act of March 2, 1945, authorized " * * * to be appropriated out of any money in the Treasury not otherwise appropriated, the sum of $120,000 to be immediately available as an emergency fund to be expended under the direction of the Secretary of War and the supervision of the Chief of Engineers for repairing damage to and checking erosion on the Bayocean Peninsula, in Oregon, caused by a storm in January, 1939, in order to provide adequate protection to property on such peninsula and in Tillamook, Oregon." While the authorization has never been revoked, no funds were appropriated and the work was not initiated. The stated amount was inadequate to provide the desired protection.

39. Local cooperation. - Local cooperation in the matter of providing improvements in the interest of navigation has been as indicated in the following tabulation.

River and Harbor Act	Project	Local requirement	Amount contributed
Aug. 11, 1888	Improvement of Dry Stocking Bar and Hoquarten Slough.	None	None
July 13, 1892	Dredging channel 200 feet wide and 6 feet deep between north and middle channels above Bay City, and construction of various control dikes.	None	None
July 25, 1912 Mar. 4, 1913	Construction of north jetty 5,700 feet long; dredging channel to Bay City 16 feet deep, 200 feet wide.	Contribute one-half of first cost of north jetty. Construct and maintain a channel 9 feet deep at high water between Bay City and Tillamook.	$398,833 6,450
Mar. 2, 1919	Further improvement of Hoquarten Slough not recommended. The 9-foot channel (at high water) between Bay City and Tillamook abandoned.	Local interests released from bond and agreement to maintain 9-foot channel between Bay City and Tillamook.	None
Mar. 3, 1925	Channel to Bay City abandoned. Project modified to include an 18-foot bar channel; inner channel 18 feet deep by 200 feet wide to a turning basin 500 feet wide at Miami Cove.	House Document No. 562, 68th Congress, second session, recommended that local interests be required to contribute one-half the first cost of the new work. The River and Harbor Act approved March 3, 1925 released local interests from this requirement.	None
	A channel 16 feet deep by 200 feet wide from Miami Cove to a turning basin 500 feet wide at Hobsonville.	A sawmill of substantial capacity to be erected in vicinity of Hobsonville.	No sawmill ever erected. No work has been done on on channel.
June 30, 1948	Dredging small-boat basin and approach at Garibaldi to a depth of 12 feet.	Easements, rights-of-way, spoil-disposal areas; maintain necessary depths in mooring basin; and construct, maintain, and operate mooring facilities and utilities open to all on equal terms.	No work yet done on small-boat basin.

40. Other improvements. - Prior to 1913, the port of Tillamook, now dissolved, expended $17,000 for maintenance of a bay channel from Bay City to the city of Tillamook. In 1919-20, prior to incorporation of the Miami Cove channel into the main project, the port of Bay City dredged a channel 150 feet wide and 16 feet deep through that stretch at a cost stated to have been $265,000. Local interests report other expenditures in aid of navigation on the bay as (1) basin at Bay City, $5,000; (2) channel improvement at mouth of Kilchis River; (3) small-boat basin at Garibaldi, $30,000; total $722,283.

41. Terminal and transfer facilities. - In the lower 4 miles of Tillamook River, there are several log dumps where a large volume of logs are unloaded from trucks for rafting to Garibaldi and Hoquarten Slough. At Bay City there is a small wharf owned by the city and open to all on equal terms, also a fish-receiving and supply wharf which has about 100 feet of frontage and power-lift equipment. There is also a small-boat basin with landing berths, serving fishing interests. At Garibaldi, the mill wharf has about 125 feet of frontage where barges and small coastwise ships load lumber. There is also a small-boat basin with landings for receiving fish and delivering supplies, and for other purposes including space for Coast Guard craft. Terminal and transfer facilities appear adequate for present commerce.

42. Improvement desired. - At a well-attended public hearing, held at the County Court House in Tillamook, Oreg., April 15, 1953, local interests presented data to support their request for improvements to preserve and maintain navigation facilities and other assets of the Tillamook Bay area. ~~A transcript of the public hearing is submitted herewith.~~ DELETED BY NED A communication from the Tillamook County Court dated April 1, 1953, reads as follows:

> "We wish to acknowledge receipt of the notice from your office regarding the public hearing to be held on Tillamook Bay and Bar and from a study of the information contained therein, it has occurred to us that some advance information may offer considerable aid in completing your investigation at the earliest possible date. We believe that practically all local interests concur regarding the time element and urgency of the matter under investigation.
>
> "The particular information in the public notice is "The character and extent of improvement desired". As the sponsoring body of the investigation regarding the breach in the peninsula, we are requesting the following:
>
> > "1. The immediate construction of a breakwater which will afford protection to the inner bay navigational channels, the existing entrance channel, and the preservation of other economic assets that are allied to navigation, which may be seriously affected from results of the breach in the peninsula.
> >
> > "2. For further consideration of navigation interests, it is requested with great emphasis, that the existing navigation project be maintained at depths according to those authorized by the Federal Government.
>
> "Although some deviation in the character and extent of the improvement desired will be expressed at the public hearing, we believe our request will be supported by a large majority related to navigation and the justification for the improvement.
>
> "Thanking you for your cooperation, we are,
>
> TILLAMOOK COUNTY COURT
>
> /s/ O. E. Effenberger
> County Judge
>
> /s/ Wesley Schulmerich
> County Commissioner
>
> /s/ August Schollmeyer
> County Commissioner"

43. Commerce, ocean. - In the 6 years ending December 31, 1952, ocean commerce has moved in and out of Tillamook Bay as shown in the following tabulation.

Year	Tons 2,000 pounds: Logs: Outbound	Logs: Inbound	Lumber outbound	Fish and crabs inbound	Other cargo inbound	Total
1952	76,783[1]	not available	22,695[1]	- - - - - not available - - - - -		
1951	114,007	3,344	14,799	--	--	132,150
1950	145,480	659	--	--	--	146,139
1949	38,416	--	--	471	342	39,229
1948	46,008	--	--	601	--	46,609
1947	14,896	--	--	--	--	14,896

1 Preliminary figures.

NOTE: Destination of outbound logs: Grays Harbor and Columbia River.
Destination of outbound lumber: Southern California.
Source of inbound logs: Other ports.
Fish and crabs: From fishing grounds.
Other cargo: From California.

44. Commerce, internal. - During the 5 years ending December 31, 1951, local commerce moved between various points on the bay as shown in the following tabulation:

Year	Tons, 2,000 pounds: Rafted logs (between upper and lower bay)	Rafted logs (between Hoquarten Slough and Tillamook River)	Rafted logs (at plants)	Fish (between bay points)	Total
1951	460,943	66,982	not available	737	528,662
1950	562,477	67,125	72,283	544	702,429
1949	165,802	32,078	115,240	252	313,372
1948	283,509	39,065	4,130	398	327,102
1947	149,278	40,927	9,462	1,041	200,708

45. Vessel traffic. - Vessel traffic on Tillamook Bay, including the ocean entrance thereto, for the 5 years ending with 1951, was as shown in the following tabulation.

Year	Draft		
	7 to 14 feet (trips)	Under 7 feet (trips)	Total (trips)
1951	359	1,878	2,237
1950	489	1,276	1,765
1949	152	18,192	18,344
1948	184	11,519	11,703
1947	157	3,809	3,966

46. Vessels of deeper draft (7 to 14 feet) are ships, seagoing tugs, and barges, which are loaded with logs and lumber at Garibaldi and destined to other Pacific Coast ports. The ligher-draft vessels are fishing craft, empty barges, and towboats used for towing rafts and doing other marine work usual in coastal harbors. In 1951, about 20 percent (132,000 tons) of all waterborne commerce used the Federal project channel between the ocean and Miami Cove; 70 percent (461,000 tons) used the full 11-mile length of non-Federal bay and Tillamook River channels, and 10 percent (68,000 tons) moved over short stretches, principally between log booms in Tillamook River and Hoquarten Slough. Percentagewise, use of the bay channel has remained substantially constant in the past 5 years while use of the entrance to Miami Cove channel has increased from 7 percent in 1947 to 20 percent in 1951.

47. The following tabulation shows the percent of commerce that moved over each stretch in the years shown:

Year	Federal project, bar, entrance, and Miami Cove	Non-Federal, bay and Tillamook River channels	Non-Federal, Tillamook River, Hoquarten Slough, and at plants
	Percent		
1951	20	70	10
1950	17	66	17
1949	11	47	42
1948	13	76	11
1947	7	69	24

48. Difficulties attending navigation. - The entrance to Tillamook Bay, which has been improved by construction of the north jetty and by dredging, has always been somewhat hazardous during winter months inasmuch as there is no protection from southerly swells which frequently break across the entrance. Also, strong northwest summer winds occasionally interfere with navigation. Annual shoaling occurs in the channel near Garibaldi and in the turning basin at the upper end of the project. Since the break in Bayocean Peninsula, Kincheloe Point has extended, by accretion of sand and gravel, to the north and northwest. This action has resulted in narrowing the entrance channel to a usable width of not over about 150 feet at low tide, and current velocities have been considerably increased. Also, the old swash channel due west of Kincheloe Point has been almost completely filled in with sand. In one place, the narrowed entrance channel is crowding the jetty to the point where serious damage to the jetty as a result of undercutting appears imminent. The interior bay channel, which extends by a tortuous route from Miami Cove to the mouth of Tillamook River, has been shoaled by wave action through the break-through at Bayocean Peninsula. The combination of reduced channel depths and greatly increased wave action has caused serious interference with the movement of log rafts on that channel.

49. Water power and other special subjects. - Water power is not involved in the subject under review. In addition to the effect on the existing navigation project, the break in Bayocean Peninsula has destroyed a portion of the oyster beds and constitutes a real threat to the remaining beds. Also, breaching of the peninsula removes the only barrier between the sea and shore lands, some of which are diked to protect about 2,000 acres of agricultural land. Storm waves, ground swell, and tides reduce the freeboard of dikes and cause erosion and general deterioration.

50. Survey. - A field survey of the area in the vicinity of the breach in Bayocean Peninsula was made during January and February 1953. Hydrographic surveys of the entrance and channel to Garibaldi and of the interior bay channel were made in March and April 1953. Results of these surveys are shown on the accompanying drawing. Probings and jet borings were made to determine the character of the sub-base material opposite the break. Samples taken at 5-foot depths show that the sub-base material consists of sand, gravel, and organic silt with clay underlying some areas.

51. Plan of improvement. - Methods for closing the gap in Bayocean Peninsula studied in this report include structures of various types on four different alignments. After consideration of all pertinent factors, including maintenance costs, it was concluded that any closing structure should be constructed between Pitcher Point and the town of Bayocean, a distance of 7,600 feet, about as shown on the accompanying drawing. On that alignment, a considerable distance shoreward from the break, it was believed that the structure would be subjected only to moderate wave action inasmuch as the heights of waves entering from the open sea would be considerably reduced while traveling across the shoal areas in front. The principal types of structures investigated were sand fill; sand, gravel, and rock structure armored on the seaward face; and a rock dike with a flat sand fill constructed on the seaward side. In the latter two plans, closure of the deeper channels was proposed to be accomplished by use of quarry-run rock. Subsequently, the rock dike would be raised to a height of 20 feet above mean lower low water. In the sand fill plan, final closure would be facilitated by construction of pile bulkheads across the deeper washes. After careful consideration of all plans and factors pertaining thereto, the conclusion has been reached that an economical and satisfactory closure can be accomplished by means of a sand fill constructed with a long, flat slope (1 on 20) on the seaward face; crest elevation of 20 feet, top width of 200 feet, and a slope of 1 on 10 on the bay side. Waves that reach the structure, it is believed, would be largely spent on the flat foreshore of the fill and under normal conditions should not speedily erode the sand fill. Storm waves, occurring during the higher tides, however, might cause some erosion. Repair of damage caused thereby is provided as maintenance. Filling on the bay side at the northerly end of the gap to maintain sufficient width to insure against flanking the northerly end of the sand fill also is provided under maintenance. Some difficulty is anticipated in making closures in tidal exchange areas even after provision of pile bulkheads and some losses of sand will undoubtedly occur during pumping operations. The amount of such loss is largely conjectural but has been estimated at from 10 to 20 percent

of the volume. Compensation for losses during pumping has been included in estimates contained herein by increasing the per yard price for sand in place by about 15 percent. Due to a soft foundation at the location selected for the closing structure, some settlement of a sand fill is anticipated. Also, there will be some shrinkage of material placed in the fill. To cover these items, quantities have been increased by 28 percent over those calculated within the neat lines of the section. The estimates of quantities shown below are believed to be adequate for the closure fill. Estimates of annual maintenance, which are shown below, include cost of preventive measures or repairs that may be necessary on account of wind erosion as well as for the replenishment of sand removed by wave action.

52. It is proposed to obtain material for the sand-fill structure from areas along the northeasterly side of Kincheloe Point and it will be pumped a distance averaging about 2 miles. With adequate maintenance, the life of the sand-fill structure is estimated at 50 years.

53. Aids to navigation. - No additional aids to navigation would be required as a result of the improvement considered herein. The existing Federal navigation channel, located from 2 to 3 miles to the north and northeast of the proposed closure structure, is adequately marked by range lights and buoys. The inside channel, from Garibaldi to Bay City and thence to the mouth of Tillamook River, is marked by lighted dolphins. All navigation markers in the Tillamook Bay area are maintained by the United States Coast Guard.

54. Shore-line changes. - Closure of the break in Bayocean Peninsula by means of a sand fill would, in all probability, have some effect on adjacent shore lines. The area seaward of the considered structure would be expected to fill in to some extent, probably at the expense of the beach areas to the north and south. During the first few years, the loss of material from the adjacent beaches would be most noticeable near the ends of the breakthrough, although the effects of the initial readjustment probably would not be immediately discernible for any great distance. Over an extended period of time, the tendency undoubtedly will be for the shore line to straighten through a slow process of erosion along protruding areas and deposition along indentations. The only such erosion area of any concern is seaward from the settlement of Cape Meares, at the south end of the former peninsula. Most of this settlement of some 45 houses is located on fairly high ground. The beach fronting the settlement consists of a conglomerate mixture of sand, gravel, and clay, and has been eroding slowly for several years. Consideration was given toward some means of arresting the erosion as a part of the over-all plan of improvement for closing the break in the peninsula. However, no satisfactory means could be found for protecting the shore line adjacent to the settlement of Cape Meares. Moreover, the area under consideration is privately owned and no separate means of protection against wave action could be undertaken by the Federal Government.

55. Estimates of first cost and annual charges. - The estimated quantities of material involved, and costs based on December 1953 price levels, are as follows:

Federal:

Dredged sand fill, 2,978,000 cu. yds. @ $0.40	$1,191,000
Solid pile bulkhead, lump sum	88,000
	1,279,000
Contingencies	256,000
	1,535,000
Engineering and Government costs	215,000
	1,750,000
Less cash contribution	250,000
Total Federal cost	1,500,000

Non-Federal:

Lands and rights-of-way, lump sum	20,000
Road reconstruction	5,000
Cash contribution	250,000
Total non-Federal cost	275,000
GRAND TOTAL FIRST COST	$1,775,000

Annual charges are as shown below:

Federal:

Interest @ 2½ percent	$ 37,500
Amortization, 50 years, 1.026 percent	15,400
Maintenance	25,000
Total Federal annual charges	77,900

Non-Federal:

Interest @ 2½ percent	6,900
Amortization, 50 years, 1.026 percent	2,800
Total non-Federal annual charges	9,700
TOTAL ANNUAL CHARGES	$ 87,600

56. Present navigation benefits. - Transportation savings now being realized by reason of the existing navigation project through the entrance and to Miami Cove, based on tonnage moving over the project during 1950, 1951, and 1952, are estimated as shown below:

Movement	Tons	Savings: Per 1,000 feet board measure	Savings: Per ton	Savings: Amount
Lumber to Los Angeles area	19,000	$4.79	$2.99	$ 56,810
Logs to Grays Harbor, Wash.	27,100	4.44	1.18	31,980
Logs to Columbia River	85,000	3.45	0.92	78,200
Total	131,100			$166,990

57. The items listed constitute the only movement of ocean commerce through the entrance, with the exception of fish and crabs taken by fishermen in offshore waters. The tonnage is believed to represent fairly accurately the volume that may be expected to continue. This premise is based on the fact that new milling facilities, including another plywood plant, now are or soon will be in operation in the bay area; consequently, more logs will be processed locally. More finished materials and fewer logs will be available for ocean shipment; therefore, it is believed that commerce will be maintained at or above its present level. One of the sawmills has acquired a self-propelled carrier with capacity of 1.8 million board feet at 18 feet draft, and expects to ship approximately 20 million board feet (32,000 tons) annually.

58. In the 11 fiscal years 1942 through 1952, Federal maintenance of the project, including jetty repairs, cost $178,390; an average of $16,217 per year. Total annual cost to the Federal Government, including maintenance, interest at 2½ percent, and amortization on a 50-year basis, is $36,472 ($574,447 cost of new work at 2½ percent interest equals $14,361 plus 1.026 percent amortization equals $5,894). The net annual benefits to the public are, therefore, $166,990 minus $36,472, or $130,518.

59. Navigation benefits now accuring annually to the public from use of the natural non-Federal channels in Tillamook Bay between Garibaldi and points in Tillamook River, a distance of 8 to 11 miles, are estimated to be 39 cents per ton on 300,000 tons, or $117,000. No costs to local interests have been incurred in recent years.

60. Unit savings have been determined by the usual methods of comparing the cost of movement by water with the lowest cost alternate land route, with due allowance for all differentials in handling, transfer, wharfage, and so forth, details of which are contained in the appendix hereto.

61. Navigation benefits creditable to the proposed sand-fill structure. - As shown above, present use of the navigation channels in Tillamook Bay for water-borne commerce results in net benefits to navigation of $247,518 ($130,518 from the Federal project and $117,000 from the non-Federal bay channel). During the full year which has elapsed since the breakthrough occurred, the entrance channel has rapidly become so narrow, and current velocities increased to such an extent, that navigation of the channel has become extremely hazardous. It appears that, unless the break in Bayocean Peninsula is closed, the former entrance channel may soon be rendered completely useless. Considering the rapidity with which the entrance channel has deteriorated, preservation of this channel by means of maintenance dredging alone appears impracticable. The benefits creditable to this channel as a result of closing the breach in the peninsula, therefore, would be the net navigation benefits received before the breakthrough occurred. As described above, this averaged $130,500 ($130,518 rounded off) annually. Also, in the event the entrance channel had to be abandoned, there would be a considerable loss in unamortized investment, both Federal and non-Federal. However, for the purpose of this report, no monetary value has been included to cover this possibility. The bay channel has already shown the effects of the breakthrough in Bayocean Peninsula. Shoaling of this channel, most of which occurred as a result of storm waves during the remainder of the winter after the breakthrough, has compelled towing operators to confine their operations to high-water periods only. In addition, increased wave action along a portion of this channel has broken up several log rafts. For this reason, towing operators are now forced to use two towboats for each rafting operation, the additional boat usually following along behind to retrieve logs which slip out underneath the boom sticks and to be available for assistance in case a break-up occurs. It is estimated that at least 1½ dredge-months operation would be required annually to maintain the bay channel to its previous depth. In estimating costs, consideration has been given to mobilization, demobilization, operating costs, and the time element involved, which is probably a more vital consideration than

the actual depth of cut. It is estimated that the average cost of mobilizing, demobilizing, and operating a pipe-line dredge in Tillamook Bay would be about $45,000 per month. On this basis, benefits resulting from closing the break in the peninsula and creditable to the bay channel for maintenance dredging only, would total $67,500 annually. For the purpose of this report, delays in rafting operations as a result of shoaled conditions and increased operating expenses involved in using an additional towboat, have not been evaluated. Total navigation benefits creditable to the proposed sand-fill structure are, therefore, $198,000 annually ($130,500 plus $67,500).

62. Benefits from protection of remaining oyster beds. - The breakthrough of Bayocean Peninsula has caused a serious threat to the oyster industry in Tillamook Bay. Approximately 3,000 acres of tide lands are now leased as oyster claims in Tillamook Bay on which the Pacific Oyster (ostrea gigas) is grown or cultivated. Approximately one-third of the beds have been or are being covered by sand and thus destroyed. Remaining oyster beds comprise approximately 2,000 acres, and covering of these with sand is anticipated to occur more or less gradually, the rate of which they are covered will depend upon severity of storms coinciding with high tides and major changes in topographic and hydrographic features which are bound to occur if the breach is not closed. It appears that 75 percent of the remaining oyster beds probably would be destroyed by deposition of sand if the break were allowed to remain open. Once an oyster bed has been covered with sand its productivity is lost until sufficient mud is redeposited to support oysters which, even with closure of the gap, would require an indeterminate period of time. The oysters have a tendency to settle in the sand until they become covered and suffocate. A mud bottom is ideal for oyster culture, and tide lands consisting of a very soft mud will grow and hold oysters while a seemingly firm sand will not. Much of the bed of Tillamook Bay was originally covered with mud.

63. Damages which have already occurred are not considered pertinent to this study, consideration being given to determination of the benefits which would accrue to approximately 2,000 acres of remaining oyster beds as a result of closure of the break and prevention of encroachment of sand thereon. The average value of the oyster lands is conservatively estimated at $500 per acre. Estimates of local interests range up to $1,000 per acre for highly productive area. In addition, the value of plant and equipment is conservatively estimated at $120,000. Assuming that 75 percent (1,500 acres) of the remaining oyster beds would be destroyed in a 50-year period if the opening through Bayocean Peninsula is not closed, and that the value of plant and equipment rendered unusable by virtue of the loss of oyster beds would be about 75 percent of the total value, the benefits of closure to the industry would be protection of the earning power of, or return on, the investment in the industry. The investment values are as follows:

1,500 acres @ $500 per acre	$750,000
75 percent of $120,000, plant and equipment	90,000
Total	$840,000

Over a 50-year period, the average annual loss in investment would be $\frac{\$840,000}{50}$, or $16,800. Assuming an interest rate of 7½ percent as a fair value of return on investment in land, plant, and equipment in the oyster industry, each year, earnings would be decreased by $16,800 x 0.075, or $1,260. At an interest rate of 4 percent, which rate corresponds to the minimum current cost to private borrowers for obtaining funds through mortgage loans, the present worth of the uniformly increasing loss in earning power would be $482,140. This value, converted to an equivalent uniform annuity for a period of 50 years at the same rate of interest, would be $482,140 x 0.04655 = $22,450.

64. Potential damages in diked tide lands. - Some 2,000 acres of lands protected by dikes along the southeasterly side of Tillamook Bay are subject to potential damage by increased wave action. The protecting dikes for these areas are in the direct path of swells propelled through the break in Bayocean Peninsula. When the first break-through occurred during a coinciding storm and high tide in November 1952, there was considerable apprehension among the owners of the diked lands. They reported higher tidal elevations along the dikes than formerly and a considerable increase in wave action. It appears that future coincident occurrences of high tides and severe storms could result in considerable damage to the earth dikes. Under normal conditions, however, the ocean waves are fairly well broken up when crossing shoal areas at the break-through and have not, to date, caused serious damages to the dikes. It is considered impracticable to evaluate potential damages at this time although considerable future benefits would accrue to diked lands from closure of the break in Bayocean Peninsula. Such damages would be due principally to tidal and wave action.

65. Secondary benefits. - Industries. - Substantial secondary benefits would result to industries as a result of construction of the proposed sand-fill structure because of the aid it will give toward maintaining their present status. The fact that these benefits cannot be evaluated does not make then any less real. The economy of the whole county received a severe set-back as a consequence of successive forest fires in 1933, 1939, and 1945, which killed and partially destroyed more than 13 billion board feet of highest grade saw timber. Production and manufacture of forest products, the principal industry and pay roll of the county, was almost paralyzed for several years, and many millions of dollars were cut from the tax rolls. Recovery has been partially accomplished by intensive and extensive salvage operations aided by the high level of prices for timber products. The proposed improvement would benefit the mills and boat operators who use the navigation channels. Also, it would help to maintain the general level of employment among all mill workers, loggers, truckers, servicing concerns, and mercantile establishments. The two largest pay rolls of the county, a sawmill and plywood plant located at Garibaldi at the north end of Tillamook Bay, rely almost exclusively on logs that reach the plants by towage from the south end of the bay. Closure of the bay channel or restriction of towage to high-tide periods would force the logs to be moved by truck through the main business streets of the city of Tillamook, thence over a tortuous, congested, 9-mile stretch of the United States Highway 101 to Garibaldi where a large proportion of the logs would have to be piled on land and rehandled at a substantial increase in operating costs. Such increased costs have not been determined or evaluated, nor are the increased hazards to traffic on the highway, but prevention of such increased costs and hazards would be a substantial indirect benefit.

66. Preservation of the dairy product industry is of prime importance; therefore, the prevention of damage to low-lying pastures and farm houses would constitute an incalculable indirect benefit to the entire community. The same may be said of the oyster culture industry, which provides a substantial pay roll.

67. Commercial fishing. - While commercial fishing in and adjacent to Tillamook Bay does not constitute a major industry, the prevention of further shoaling of the bay and channels would result in unevaluated benefits to that industry and those wholly or partially dependent upon it for their livelihood. Several hundred tons of fish and crabs are taken in the bay and outside waters each year. Diminution of the catch would be a noticeable loss to the economy of the area.

68. Recreation. - The Tillamook Bay beach resorts and fishing grounds are among the most popular along the Oregon coast. Shoaling of the bay would limit recreational fishing in the bay and create a loss of food fish; the prevention of such an occurrence would constitute an unevaluated indirect benefit to the community.

69. Summary of benefits and benefit-to-cost ratio. - Long-term direct benefits resulting from closing the break in the peninsula are summarized as follows:

Item	:	Annual benefit
Garibaldi channel		$130,500
Bay channel		67,500
Oyster beds		22,450
Total		$220,450

Estimated annual charges, assuming a 50-year average of $25,000 annually for maintenance, and interest and amortization of the estimated current cost based on 2½ percent, total $87,600. On this basis, the benefit-to-cost ratio would be 2.52 to 1.

70. General and local benefits. - Of the benefits to be gained by closing the break in the peninsula, those pertaining to protection and preservation of existing navigation facilities are of primary importance. Protection against further damage to the oyster beds would benefit local interests by insuring continuation of an established industry. Local benefits would also be derived from saving property damages along the easterly side of Tillamook Bay where wave action has increased due to the break in Bayocean Peninsula. The bay channel, which extends from Tillamook River to Garibaldi, is not included in the Federal project. It is, nevertheless, a navigable waterway of the United States and forms an integral part of the water transportation system of the region. Present annual commerce on the bay channel consists largely of rafted logs, of which about 300,000 tons are handled annually. In addition, the bay channel is used by commercial fishing and oyster boats, and by recreational craft. Many of the logs transported through the bay channel are shipped out over the bar in barges and some are cut into lumber for coastwise shipment from Garibaldi. Thus, the bay channel operates as a feeder to the Garibaldi Channel in the matter of ocean commerce. Use of the bay channel makes it economically feasible to move logs of marginal quality from the Tillamook burn area through savings in the cost of transporting logs from the upper end of the bay to Garibaldi. Without the bay channel, however, those logs might not move to Garibaldi by truck but could be manufactured at the south end of the bay, and an equivalent volume of better grade logs would be substituted therefor. The sawmill and plywood plant at Garibaldi combined constitute the largest pay roll in Tillamook County. Without closure of the break in Bayocean Peninsula, annual dredging would undoubtedly be required to keep the bay channel in usable condition inasmuch as progressive shoaling is now occurring all the way across the bay. Benefits to be gained by protection and preservation of the Federal project and of the bay channel which contributes a substantial volume of commerce thereto are considered to be general in nature. Benefits from protection of the remaining oyster beds are strictly local in character as are those benefits accruing from the protection of private property.

71. Proposed local cooperation. - On the basis of a cash contribution of $250,000 towards the construction cost, which appears to be the maximum amount which can reasonably be expected from a county with a population of only 18,606, the total cost to local interests would be as follows:

First cost for lands and rights-of-way	$ 20,000
Road reconstruction	5,000
Cash contribution	250,000
Total	$275,000

72. In addition to a cash contribution toward the first cost of the project, local interests would be required to provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project; to reconstruct county roads as necessary; and to hold and save the United States free from all claims for damages due to construction work. Local interests have indicated their willingness to comply with the above terms and an expanded port district has been formed which, with the older port of Bay City, has sufficient financial capability to furnish the required cooperation.

73. Allocation of costs. - The allocation of initial costs and costs of maintenance would thus be as follows:

Agency	First cost	Annual maintenance
Corps of Engineers	$1,500,000	$25,000
Local interests	275,000	-
Total	$1,775,000	$25,000

74. Coordination with other agencies. - At the request of the district engineer, the Fish Commission of Oregon conducted a study of, and submitted a report on, the economic losses sustained and to be anticipated by the oyster industry as a result of the break in Bayocean Peninsula. The commission's report, dated February 24, 1953, is included in the appendix hereto. In addition to the report on damages sustained, the commission stated that "the construction of a dike is essential if further damage to oyster and clam grounds is to be stopped. The ideal location of the dike would be along the Bayocean Spit. However, if for construction soundness it is necessary to construct the dike in the proposed location, the fact that it would be on top of some formerly productive ground would seem to be beside the point. Without protection it is unlikely that this ground will ever again be productive." The Fish and Wildlife Service has offered no objection to the proposed plan of improvement.

DISCUSSION

75. Erosion along the seaward face of Bayocean Peninsula, extending over a period of 15 years or more, has resulted in the loss of considerable beach front property and many homes. The problem has been under study by the Corps of Engineers since 1938. Until the southerly portion of the spit was breached in November 1952, and ocean waves began to enter Tillamook Bay, the problem was solely that of protecting private property. Navigation facilities within the bay and at the entrance had not previously been noticeably affected by the erosion of Bayocean Peninsula. Now, however, the problem is considered in the light of actual damages that have occurred in the immediate path of the breakthrough and the possibility that the Garibaldi channel may soon be completely closed.

76. The most exhaustive study by the Corps of Engineers was conducted in 1939 in compliance with section 8 of the River and Harbor Act of June 20, 1938 (Public No. 685, Seventy-fifth Congress; H. R. 10298), which provided for a preliminary examination and survey of "Tillamook Bay, Oregon, with a view to protection of Bayocean, and property thereon, from erosion and storms." That study, made in collaboration with the Shore Protection Board, considered various plans for the protection of the peninsula by preventing further erosion along the ocean front. One of the plans of improvement considered in the above report consisted of a series of groins throughout the length of the peninsula, supplemented by bulkheads at exposed shore locations. The groins were to be located at appropriate intervals and to extend from the toe of the barrier dune to slightly beyond the low-water shore line. The groins would have had an average length of about 500 feet and would have been constructed to a height above the beach profile in accordance with accepted standards.

77. The Shore Protection Board in its report to the division engineer, dated December 17, 1940, expressed the opinion that along a rocky and heavily timbered coastline, structures projecting into the ocean would be subject to the battering effect of large-sized logs and floating debris. Steel sheet pile groins or bulkheads supported by round piles would be of doubtful utility in such a location even though there was assurance that they would not fail as a result of underscour during adverse weather conditions. If rock jetties were used instead of groins, the size of the individual stones would necessarily be great in order to resist the severe wave action, and such jetties or groins might be subject to undermining within a few years as a result of the shoreward movement of the 30-foot contour along this frontage. Since the erosion along the peninsula created no threat to navigation at that time, the justification for groins or other protective works would have had to be considered from the standpoint of protecting private property. In view of the relatively small value of the property remaining on the peninsula and the length of shore line to be protected, the board concluded that the construction of a system of groins and bulkheads would be an undertaking of such magnitude as to preclude any possibility of justification at that time.

78. A comparison of ocean depths along the peninsula, as obtained from hydrographic surveys of 1866-67, 1885-91, 1926-27, and 1939, reveals heavy erosion within the 10-fathom curve and very extensive accretion between the 10- and 30-fathom curves. Cross sections of the beach, taken in 1946 in connection with a hydrographic survey of the inner bay, showed continuing erosion near the base of the peninsula and a small amount of accretion above the low-water line near Kincheloe Point.

79. Bayocean Peninsula was the site of a considerable boom in the early part of the present century, when a development company laid out and constructed a resort town including hotels, a natatorium, and various utilities. At that time, transportation from Portland was mostly by boat, with steamers making weekly round-trip voyages between Columbia River points and Tillamook Bay. When the operating company went bankrupt in 1914, interest in the project waned and, despite a brief revival in 1928, there has been no further development on the peninsula. The assessed valuation of the peninsula, including improvements thereon and the community of Cape Meares (formerly Oceanview) at the southern end, reached a maximum in 1915 of $550,615. Of this total, $499,975 was assessed against Bayocean. Within recent years, the assessed valuation has dwindled to about one-tenth of the previous amount. The actual damage incurred by the recent breaching of the peninsula consisted of the loss of several lots and houses, over a mile of county road, and water-supply main and power and telephone lines to Bayocean. The few remaining inhabitants on Kincheloe Point are forced to rely on water transportation for access, provisions, and drinking water. The actual monetary loss is not known.

80. Probably the first actual damage within the bay, following the break in the peninsula, was to the oyster beds, the most productive of which were located in the protected cove adjacent to the narrow portion of the peninsula. Some of the oyster lands are valued as high as $1,000 per acre, depending upon location with respect to protecting headlands, and depth and type of accumulated silt. Of the 3,000 or more acres of tide land leased as oyster claims, one-third have already been covered by sand washing through the break. Unless some means of preventing further sand encroachment is provided, additional acreage undoubtedly will be destroyed during each succeeding storm. There is no known method of artificial rehabilitation for beds so destroyed.

81. Prior to 1913, the port of Tillamook, now dissolved, maintained a shallow-draft bay channel to Tillamook city, and small oceangoing vessels were able to navigate to that point. Small schooners disappeared from the coastwise trade at about the time of the first world war (1914 to 1918), and the River and Harbor Act of March 2, 1919, modified the then-existing project to the extent of abandoning the channel above Bay City and releasing local interests from their obligation to maintain that channel. Within recent years, use of the bay channel has been revived and log rafts are towed over the channel from log dumps located on Tillamook River to the booming grounds at Garibaldi. This commerce in the bay channel has become an integral part of the economy of the area, particularly in salvaging logs from the extensive Tillamook burn. Local interests claim that, since the peninsula was breached, the bay channel has shoaled to such an extent that towing operations have been restricted to only one trip per day during the higher high tides, weather permitting, and the operation now requires the use of an extra towboat on account of the condition of the channel. During high tide, when the sea is rough, waves pass through the break and roll almost unrestricted across the bay. The increased wave action causes logs to slip out beneath the boom sticks, or causes the rafts to break up completely. Formerly, two rafts were towed to Garibaldi each day during ordinary high water. Inasmuch as the booming grounds at Garibaldi have limited storage capacity, the sawmill and plywood plant soon used up the reserve supply of logs and have since been operating on a curtailed schedule. The amount of additional shoaling that will occur in the future can only be surmised. Based on the amount of shoaling that has taken place during the first winter following the break, complete deterioration of the bay channel appears inevitable unless the break is closed so as to protect the bay against further damage. The only alternative to closing the break in the peninsula would be almost continuous dredging.

82. The existing Federal navigation channel, located along the north end of the bay is being seriously damaged by the northerly encroachment of Kincheloe Point, which encroachment has caused an alarming narrowing of the channel, increased velocities, and difficulties in navigation. There is the further possibility that if the condition remains uncorrected, undermining of the jetty may occur. The large opening through the peninsula is now an outlet for a large portion of the tidal outflow.

83. Approximately 2,000 acres of valuable dairy land along the bay, and tidal portions of the rivers emptying into the upper bay, are partially protected against tidal overflow by means of low earth levees. These lands, which have never been fully protected against extreme high tides, overflow as a result of river floods, or a combination of both floods and high tides. Immediately after Bayocean Peninsula was breached, local residents were alarmed at the prospects of their levees being overtopped as a result of increased surge on top of high tides. Several areas were inundated. Aside from the temporary inconvenience, however, actual damage to date from salt water has been considerably less than was feared initially. By closing the break in the peninsula, troublesome surge action would be eliminated and the previous degree of protection would be restored.

84. Borings of the bay area east of the break in the peninsula, taken in January 1953, show that the sub-base material consists of sand, gravel, and organic silt, with clay underlying some areas. In view of the nature of materials found, considerable, although not excessive, settlement of a structure is anticipated. Of the various types of closure structures investigated, a sand fill appears to be most practicable, both from the standpoint of effectiveness, availability of materials, and rapidity of construction. The estimated construction cost and average annual maintenance are $1,750,000 and $25,000, respectively. The above figures include a substantial allowance for settlement, shrinkage, and loss of material during construction.

85. Direct benefits to be derived from closing the gap in the peninsula consist of savings due to prevention of complete deterioration of the Federal navigation channel, from the entrance to Garibaldi; savings in the cost of keeping in usable condition the bay channel along the east side of the bay from Garibaldi to Tillamook River; and prevention of loss of about 75 percent of the remaining oyster beds in the bay.

86. Benefits to be gained by preservation of the Garibaldi channel, which is a part of the existing Federal navigation project, are considered general in nature. Benefits from protection of the remaining oyster beds are considered strictly local in character. Insofar as the bay channel is concerned, although it is not at this time included within the Federal project, use of this channel affects the operations of a sawmill, a plywood plant, towing concerns, trucking operators, and other industries closely associated with the manufacture of lumber, and provides a means of low-cost transportation for logs routed to the mills at Garibaldi for manufacture into lumber for ocean shipments, or which are loaded on barges for shipments to other coast ports. In view of the very close relationship between the bay channel and the existing project channel in connection with the entire lumbering operation in Tillamook County, including salvaging of logs from the burned areas, it appears there is a Federal interest in maintenance of present facilities in the interest of economical water transportation and savings to the public.

87. Based on statements obtained from local residents engaged in the oyster industry, and corroborated by the Fish Commission of Oregon, good oyster land ranges in value as high as $1,000 per acre. From these statements, it is conservatively estimated that the remaining 2,000 acres of undisturbed lands, if protected, would have revenue producing ability represented by an average valuation of $500 per acre on a long-term basis. While it is impossible to determine with any certainty the additional acreage which might be destroyed if the break in the peninsula were allowed to remain open, it was estimated that as much as 75 percent of the remaining oyster lands might eventually become wholly or partially covered with sand and thus rendered useless for an indeterminate period of time. An equal percentage of plant and equipment would be rendered unusable by virtue of the loss of oyster beds. The benefit to the oyster industry, by closure of the peninsula break, would be protection of, or return on, investment in the industry. Based on $7\frac{1}{2}$ percent as a fair value of return on investment, and assuming that, over a 50-year period, the average annual loss in investment would be $\frac{\$840,000}{50}$, or $16,800; the income loss for each year would increase by $16,800 x 0.075, or $1,260. At an interest rate of 4 percent, which rate corresponds to the minimum current cost to private borrowers for obtaining funds through mortgage loans, the present worth of the total loss of income would be $482,140. This value, converted to an equivalent annual annuity for a period of 50 years at the same rate of interest, would be $22,450. Prevention of this equivalent annual loss is considered a measure of the benefit to the oyster industry, and would be local in nature.

88. The above direct benefits are considered to be the only ones subject to anything approaching true evaluation at this time. The full effects of the peninsula breakthrough are now becoming readily apparent. However, greater damages could easily develop if the peninsula gap is allowed to remain open. If the gap were to be closed, indirect benefits would be gained by protecting the present status of the bay. These would directly affect the surrounding community, and, to a lesser degree, the entire county. The evaluated direct benefits of $220,450 (see paragraph 69), when compared with the estimated annual charges of $87,600 (see paragraph 55), produce a benefit-to-cost ratio of 2.52 to 1.

89. It is believed that an amount of $250,000 is about the maximum that could reasonably be expected to be contributed by a county with a population of only 18,606. The share to be contributed toward the total first cost by the Federal Government would be $1,500,000. The local contribution would not exceed $250,000 in cash, plus lands and rights-of-way and reconstruction of county roads as necessary.

90. Since the breakthrough occurred in Bayocean Peninsula, local interests have expanded the area formerly embraced within the port of Bayocean, and subsequently changed its name to the port of Tillamook Bay. Another port district, the port of Bay City, has been in existence for many years. The two port districts have recently concluded an agreement to operate jointly in the matter of complying with the specified terms of local cooperation. These two port districts cover the western portion of Tillamook County and together have substantial financial responsibility.

91. If an early closure of the breakthrough in Bayocean Peninsula is not made, greater deterioration of the navigation channels is inevitable, more acreage of oyster lands will be destroyed, and dikes protecting valuable agricultural lands will be subjected to damage by increased wave action along the easterly side of the bay. With conditions as they are now, it is not believed that closure would be difficult. Widening and deepening of the present opening, however, could conceivably result in formation of a sizable outflow channel that would be difficult and costly to close. The problem is considered urgent in view of the need for minimizing construction costs and preventing further and more serious damage in Tillamook Bay, particularly deterioration of the navigation channels. For these reasons, it is believed that authorization of the project and appropriation of funds therefor should be given a high priority.

CONCLUSION

92. It has been found that protection and preservation of the existing navigation project and of the auxiliary channel in Tillamook Bay would result in benefits of $198,000 annually to the public. Protection of the remaining oyster beds would result in benefits of $22,450 annually to local interests. In addition to the benefits from protection of the remaining oyster beds, local interests would receive other benefits which have not been evaluated. Construction cost of closing the breach in Bayocean Peninsula is estimated at $1,750,000. This expenditure, plus the costs to local interests, appears to be amply justified economically on the basis of Federal and non-Federal benefits. Time is of the essence if construction costs are to be kept to a minimum and further damages prevented. It is estimated that construction could be accomplished in one working season, March to October, inclusive, which would require allotment of Federal funds in each of two successive fiscal years. Substantial local cooperation is an essential requirement.

RECOMMENDATION

93. Closing the break in Bayocean Peninsula is recommended as a separate project to aid in preserving and maintaining the existing navigation project for Tillamook Bay and Bar, Oreg., and other assets of the Tillamook Bay area, substantially as shown on the accompanying drawing, at an estimated construction cost of $1,750,000 and annual maintenance cost of $25,000, provided local interests furnish to the United States all lands, easements, and rights-of-way necessary for construction of the project; make necessary changes in roads; hold and save the United States free from all claims of damages due to construction work; and make a cash contribution of 15 percent of the estimated construction cost of the improvement, but not to exceed $250,000.

T. H. LIPSCOMB
Colonel, Corps of Engineers
District Engineer

NPDGP
NPD 813 (Tillamook Bay)
Portland District

1st Ind.

Office, Division Engineer, North Pacific Division, Corps of Engineers, 500 Pittock Block, Portland 5, Oregon. 23 December 1953

TO: Chief of Engineers, Department of the Army, Washington 25, D. C.

I concur in the views and recommendations of the District Engineer that a closure structure, substantially as outlined in the basic report, be authorized for construction at an early date to close the break in Bayocean Peninsula, at an estimated construction cost of $1,750,000 and an annual maintenance cost of $25,000; provided local interests furnish all lands, easements and rights-of-way necessary for construction of the project; make necessary changes in roads; hold and save the United States free from all claims for damages due to construction or maintenance of the project; and also make a cash contribution of 15 percent of the construction cost but not to exceed $250,000.

D. C. SHINGLER
Brigadier General, USA
Division Engineer

CORPS OF ENGINEERS

U. S. ARMY

TILLAMOOK BAY & BAR, OREGON

REVIEW 1953

PORTLAND DISTRICT, CORPS OF ENGINEERS, APRIL 16, 1953

SUPERVISED: B.A. Eddy — CHIEF, RIVERS AND HARBORS SECTION

RECOMMENDED: Ben L. Peterson — CHIEF, ENGINEERING DIVISION

SUBMITTED: Fred C. Ingram — CHIEF, PLANNING BRANCH

APPROVED: April 3, 1953 — COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED BY: A.E.M.

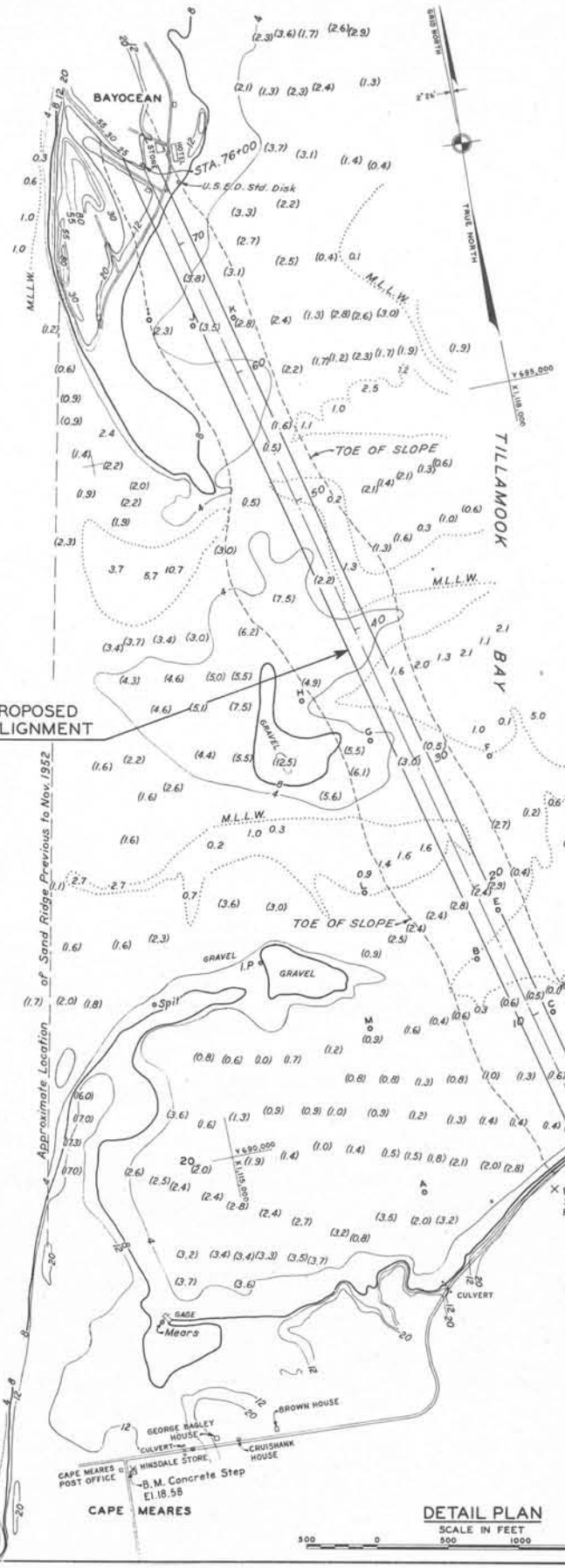
TRACED BY: D.E.P.

CHECKED BY: A.E.M.

TRANSMITTED WITH REPORT DATED APRIL 16, 1953

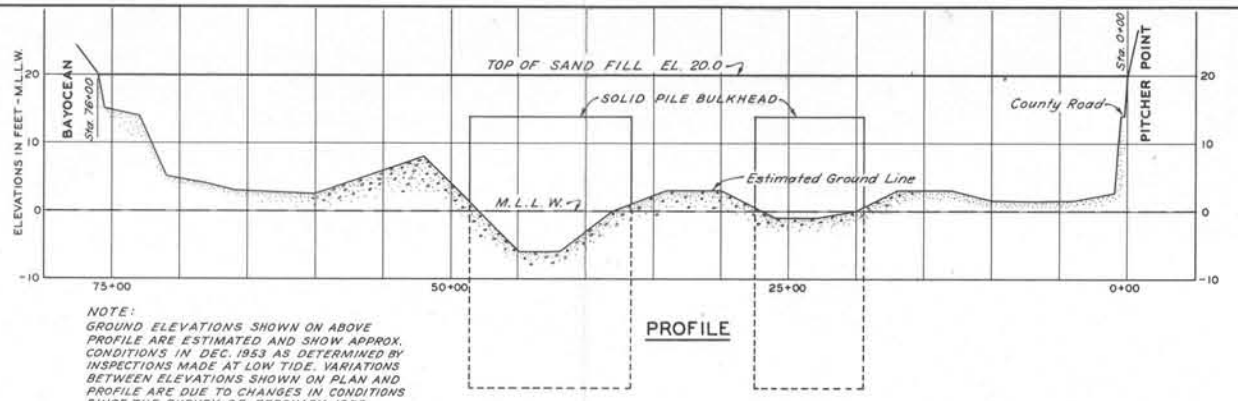
TM-1-139

REVISED DECEMBER 18, 1953



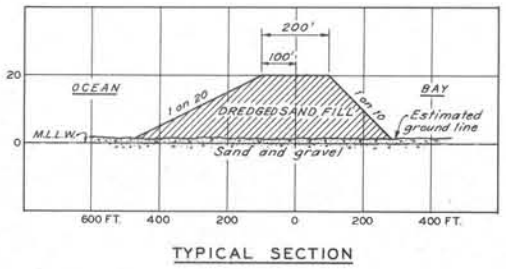
DETAIL PLAN
SCALE IN FEET
500 0 500 1000 1500 2000

Note:
Detail Plan traced from survey of Jan.-Feb. 1953.

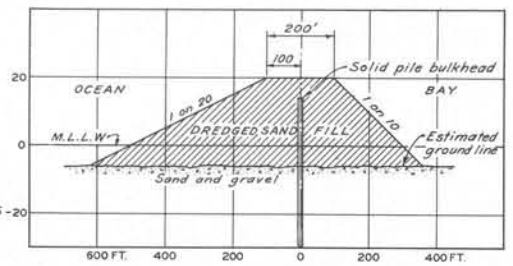


NOTE:
GROUND ELEVATIONS SHOWN ON ABOVE PROFILE ARE ESTIMATED AND SHOW APPROX. CONDITIONS IN DEC. 1953 AS DETERMINED BY INSPECTIONS MADE AT LOW TIDE. VARIATIONS BETWEEN ELEVATIONS SHOWN ON PLAN AND PROFILE ARE DUE TO CHANGES IN CONDITIONS SINCE THE SURVEY OF FEBRUARY 1953.

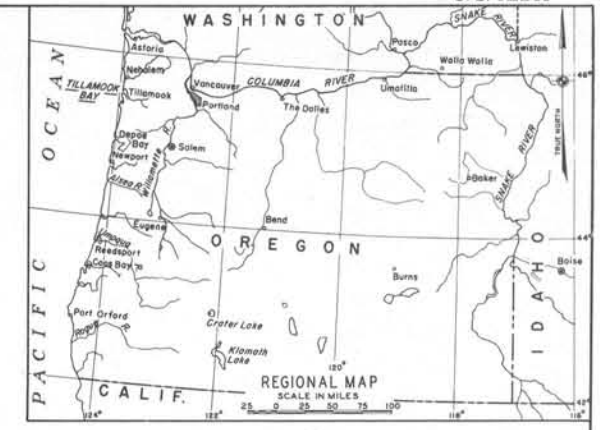
PROFILE

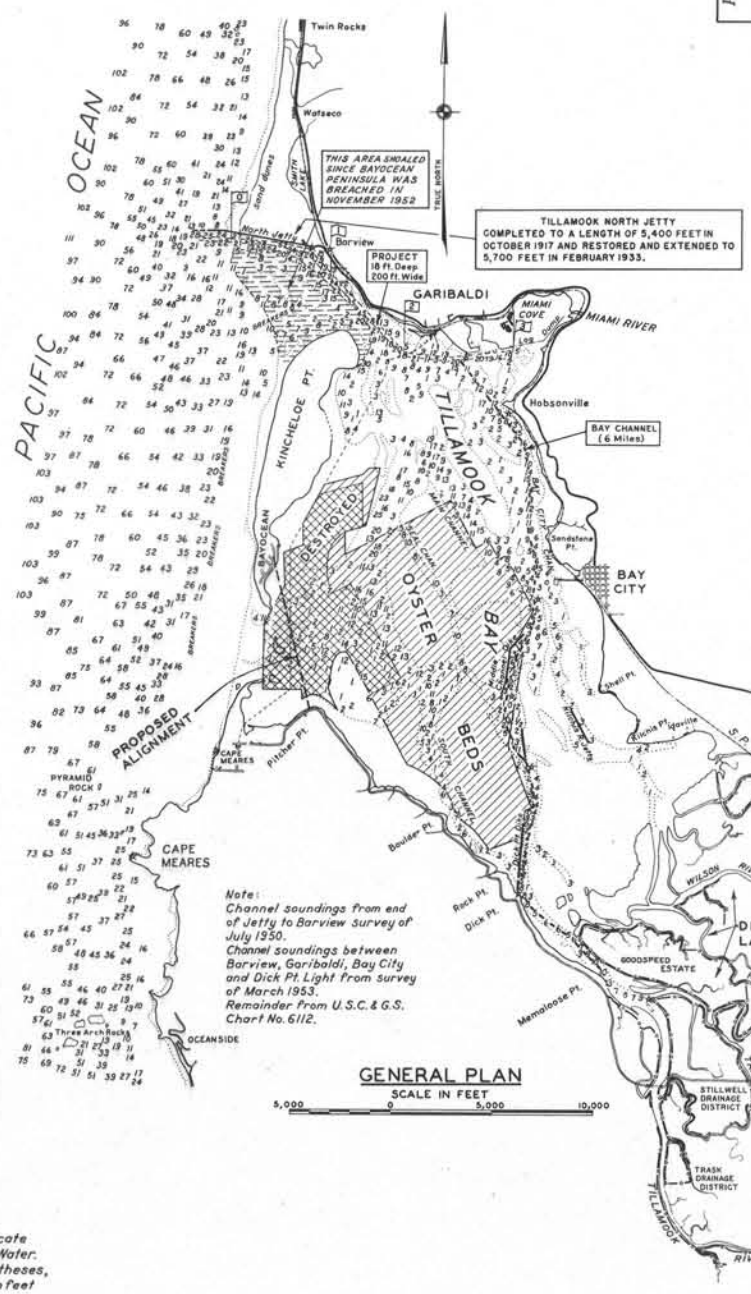


TYPICAL SECTION



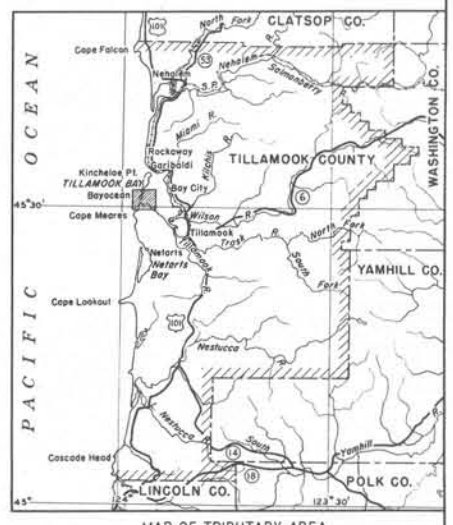
TYPICAL SECTION AT LOW AREAS



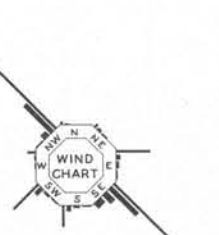


Note:
Channel soundings from end of Jetty to Barview Survey of July 1950.
Channel soundings between Barview, Garibaldi, Bay City and Dick Pt. Light from survey of March 1953.
Remainder from U.S.C. & G.S. Chart No. 6112.

Note:
Soundings are in feet and indicate depths below Mean Lower Low Water. Elevations are shown in parentheses, thus (0.8), and indicate height in feet above M.L.L.W.



MAP OF TRIBUTARY AREA
SCALE IN MILES
5 0 5 10



Mean Velocity and Duration of prevailing winds at Tillamook Bay for 19 year period.
Mean Annual Duration in days shown by length of lines.
Velocity in miles per hour shown by width of lines.

0 to 10 miles per hour
10 " 20 " " "
20 " 30 " " "
30 or more " " "

Average of 40 calm days annually.
Scale of Days
10 0 10 20 30 40 50 60 70 80 90

TABLE 1

Cost of moving lumber from Garibaldi to Los Angeles area
(per 1,000 feet, board measure)

	By ship[1]	By rail[2]
Ship rate	$15.00	
Wharfage - Garibaldi	.50	
Wharfage - destination	.25	
Handling from ship's tackle	1.15	
Marine insurance	.35	
Loading	1.35	
Back haul at Los Angeles	2.00	
Rail rate		$25.39
Total	$20.60	$25.39
Saving per 1,000 feet ($25.39 - 20.60)	$ 4.79	
Saving per ton	$ 2.99	

Derivation of charges:

1 Pacific Lumber Carriers Association Tariff 4 B, I.C.C. 15. This is an unweighted average. Terminal charges are estimates based on terminal tariffs. Back haul, arbitrary estimate. Marine insurance - ½% on $70 valuation. Tillamook Bay points not listed in any of the tariffs; therefore, Astoria rate was used.

2 Rate procured from Southern Pacific Freight Department. 69 cents per 100 pounds plus 15 percent = $0.7935. 3,200 pounds per 1,000 feet, or $25.39 per 1,000 feet.

TABLE 2

Cost of moving logs from Garibaldi to Aberdeen, Washington
(per 1,000 feet, log scale)

	Ocean barge[1]	All rail[2]
Barging	$ 9.10	
Loading to barge	1.50	
Unloading from barge	1.00	
Marine insurance	.60	
Garibaldi to Portland - rail		$ 7.88
Portland to Aberdeen		6.26
Loading to cars		1.50
Unloading from cars		1.00
Total	$12.20	$16.64
Savings per 1,000 feet ($16.64 - 12.20)	$ 4.44	
Savings per ton	$ 1.18	

(Conversion factor 1,000 feet = 3.75 tons)

Derivation of rates:

1 Sause Brothers Ocean Towing Company, Inc., rate schedule No. 3, I.C.C. No. 3.

2 Southern Pacific Company Tariff No. 235 H, 69th revised page 91, $6.85 plus 15% ($7.88). North Pacific Coast Freight Bureau Tariff No. 97 P - $43.55 per car plus 15% ($50.08). 8,000 feet per car = $6.26 per 1,000 feet. Loading and unloading estimated.

TABLE 3

Cost of moving logs from Garibaldi to Astoria
(per 1,000 feet, log scale)

	Ocean barge[1]	Truck[2]	Rail-raft via Willamette and Columbia Rivers[3]
Extension of truck haul - 60 miles		$10.80	
Barging	$4.25		
Loading to barge	1.50		
Unloading from barge	1.00		
Rafting			$ 1.00
Marine insurance	.60		.30
Loading to car			1.50
Rail to Oswego			6.10
Towing			2.50
Return of boom sticks			.35
Dog-line rental			.15
Total	$7.35	$10.80	$11.90
Savings per 1,000 feet ($10.80 - 7.35)	$3.45		
Savings per ton	$0.92		

(Conversion factor, 1,000 feet = 3.75 tons)

Derivation of rates:

1 Sause Brothers Ocean Towing Company, Inc., rate schedule No. 3. Marine insurance - 1½% on $40 valuation.

2 Willamette Tariff Bureau Tariff No. 4, 10th revised page 225.

3 No towing rates named for that movement. Costs are based on rates in opposite direction shown in Pacific Inland Tariff Bureau Tariff No. 25 A, I.C.C. No. 4. Marine insurance - 3/4% on $40 valuation.

NOTE: For all three methods, the initial cost of loading to truck would be the same.

TABLE 4

Cost of moving logs between Tillamook River dumps and Garibaldi
(per 1,000 feet, log scale)

	By raft	By truck
Towing cost	$0.50	
Sorting	0.10	
Storage	0.10	
Truck haul - additional 12 miles		$2.16
Total	$0.70	$2.16
Savings per 1,000 feet ($2.16 - 0.70)	$1.46	
Savings per ton	$0.39	

(Conversion factor 1,000 feet = 3.75 tons)

Derivation of rates:

Towing, sorting, and storage -- from Sause Brothers Towing Company, Garibaldi, by telephone December 30, 1952.

Truck haul -- from Willamette Tariff Bureau Tariff No. 4, page 225, mileage rates, effective December 29, 1952. Extension of haul 12 miles at 18 cents per 1,000 feet per mile.

C O P Y

FISH COMMISSION OF OREGON
307 State Office Bldg., 1400 S. W. 5th Avenue
Portland 1, Oregon

March 6, 1953

Colonel T. H. Lipscomb
District Engineer
U. S. Corps of Engineers
628 Pittock Block
Portland 5, Oregon

Dear Sir:

Enclosed is a survey report of the oyster beds near the Bayocean breakthrough in Tillamook Bay with an estimate of the damage to these beds. This information is being forwarded in response to your request of January 20, 1953.

Very truly yours,

/s/ A. J. SUOMELA

/t/ A. J. Suomela
State Fisheries Director

COPY

REPORT ON DAMAGE TO SHELLFISH IN TILLAMOOK BAY DUE TO BAYOCEAN SPIT BREAKTHROUGH.

Special Report

Introduction:

On or about November 13, 1952 the Pacific Ocean broke through the Bayocean Spit on Tillamook Bay and formed a sizeable channel between the ocean and bay. Although this was not the first instance of damage to the spit by the ocean it marked the beginning of the general erosion of the Bayocean Spit, and washed thousands of tons of sand and rock onto existing oyster and clam beds immediately adjacent to the bayward side of the spit. With subsequent winter storms and strong seas the damage has increased proportionately with the washing action through the break in the spit until at present its effect on oysters and clams is felt approximately one mile bayward in a direction perpendicular to the spit. The visible results are "fingers" of sand and gravel from several inches to at least eight feet in depth extending into the bay and covering up once productive oyster and clam beds.

The data contained in this report are a result of field observations (physical surveys), and personal interviews with the oyster growers and people familiar with the oystering and clam digging in the bay.

Land and Oyster Damage:

There are approximately 3,000 acres of tideland now leased as oyster claims in Tillamook Bay (Figure 1), on which the Pacific Oyster, Ostrea gigas, is grown or cultivated. An additional 2,000 acres of less desirable tideland of unknown fertility are available.

An estimated 775 acres of oyster ground of at least average productivity closest to the breakthrough have been covered with sand and gravel (shaded area in Figure 1). An additional 150 acres are partially covered and/or in the process of being covered (stippled area in Figure 1). It can be calculated, therefore, that approximately 1/3 of the existing oyster growing areas of Tillamook Bay have been or are in the process of being covered by sand and destroyed. This is a serious threat to the oyster industry in Tillamook Bay. It has put several growers out of business entirely and seriously impaired the activities of others.

The total amount of damage to oyster ground is not known and will not be known until the remaining growing ground has been planted again. It is obvious as observed by the large amounts of sand and gravel moved that the currents have changed and increased considerably. Whether or not oysters planted on the remaining ground will be able to maintain themselves without being washed off remains to be seen. Young oysters cannot "hold" themselves on an area of ground that has excessively strong currents washing over it. Oyster growers in the Tillamook Bay area claim that oysters planted on one plot have been recovered on another area as far as a mile away; this they attribute to the strong washing action of the current since the breakthrough.

It is also impossible to determine how much more sanding over of the unaffected oyster ground will occur. The pattern since the November, 1952 breakthrough has been one of gradual spreading, more and more oysters being covered by the sand. It is certainly possible that another 500 acres could be so ruined (plots 1 through 5, and 14 through 18, Figure 1).

In general a sandy flat is not satisfactory for oyster growing. The oysters have a tendency to settle in the sand more and more until they

become covered with sand and suffocate; mud is needed as a binder. Tidelands consisting of very soft mud will grow and hold oysters while a seemingly firm sand will not. Therefore, it can be theorized that a certain amount of the ground now covered with sand will never again be productive oyster ground unless silting occurs to build up the soil.

The value of the destroyed oyster ground appears highly debatable, and depends solely upon the productivity of the grounds. A piece of ground that will produce a marketable oyster in two years would be worth more than ground that would produce a marketable oyster in three years. The figures presented in Table 1 are those claimed by the oyster growers in Tillamook Bay. The Fish Commission does not have figures to show the productivity of the grounds in question and the figures are presented as quotations from the growers.

A value of $387,000 was calculated for the 775 acres already destroyed, or an average of $600 per acre. The 150 acres becoming covered with sand would boost the figure by $90,000 for a total of $477,500.

When the breakthrough first occurred a certain amount of oysters were buried or otherwise destroyed immediately. The growers were able, however, to save a certain quantity of their oysters through dredging ahead of the direction of sanding. Because of the strong currents and close lying claims, oysters owned by individual growers were mixed together. This made it doubly hard to evaluate the damage to individual growers.

The oyster loss figures in Table 1 do not include those for the largest grower, Hayes Oyster Company. Some of the oysters lost were young and unmarketable. Where this existed a potential bushelage was figured based on the amount of seed originally planted.

Clam Damage:

As in the case of the oysters, the commission does not have complete figures to estimate the exact quantity or value of clams destroyed by the breakthrough.

A considerable sports fishery for clams existed on the tideflats off Bayocean. A total of 1554 diggers counted for the period July 15 to August 20, 1950 took a calculated 26,092 pounds of clams from this area, which is no longer readily available to the general public.

It is the opinion that the commercially important clam beds of cockles (Cardium corbis), horseclams (Schizothaerus nuttallii), and soft shell clams (Mya arenaria) have not been damaged to any great extent as yet. However, this is based on an incomplete knowledge of the clam populations of Tillamook Bay.

One 20 acre and another 3 acre horseclam bed were reportedly destroyed. There were undoubtedly others also destroyed. As the Commission has no abundance figures for these beds it is impossible to set a dollars and cents value on the clams destroyed.

Effect of the Proposed Dike:

The construction of a dike is essential if further damage to oyster and clam grounds is to be stopped. The ideal location of the dike would be along the Bayoceay Spit. However, if for construction soundness it is necessary to construct the dike in the proposed location, the fact that it

would be on top of some formerly productive ground would seem to be beside the point. Without protection it is unlikely that this ground will ever again be productive.

Respectfully submitted,

/t/ Lowell D. Marriage
K. D. Waldron
Aquatic Biologists
February 24, 1953

TABLE 1

SUMMARY OF LOSSES BY OYSTER GROWERS IN TILLAMOOK BAY DUE TO BREAKTHROUGH OF BAYOCEAN SPIT.[1] Data obtained from oyster growers.

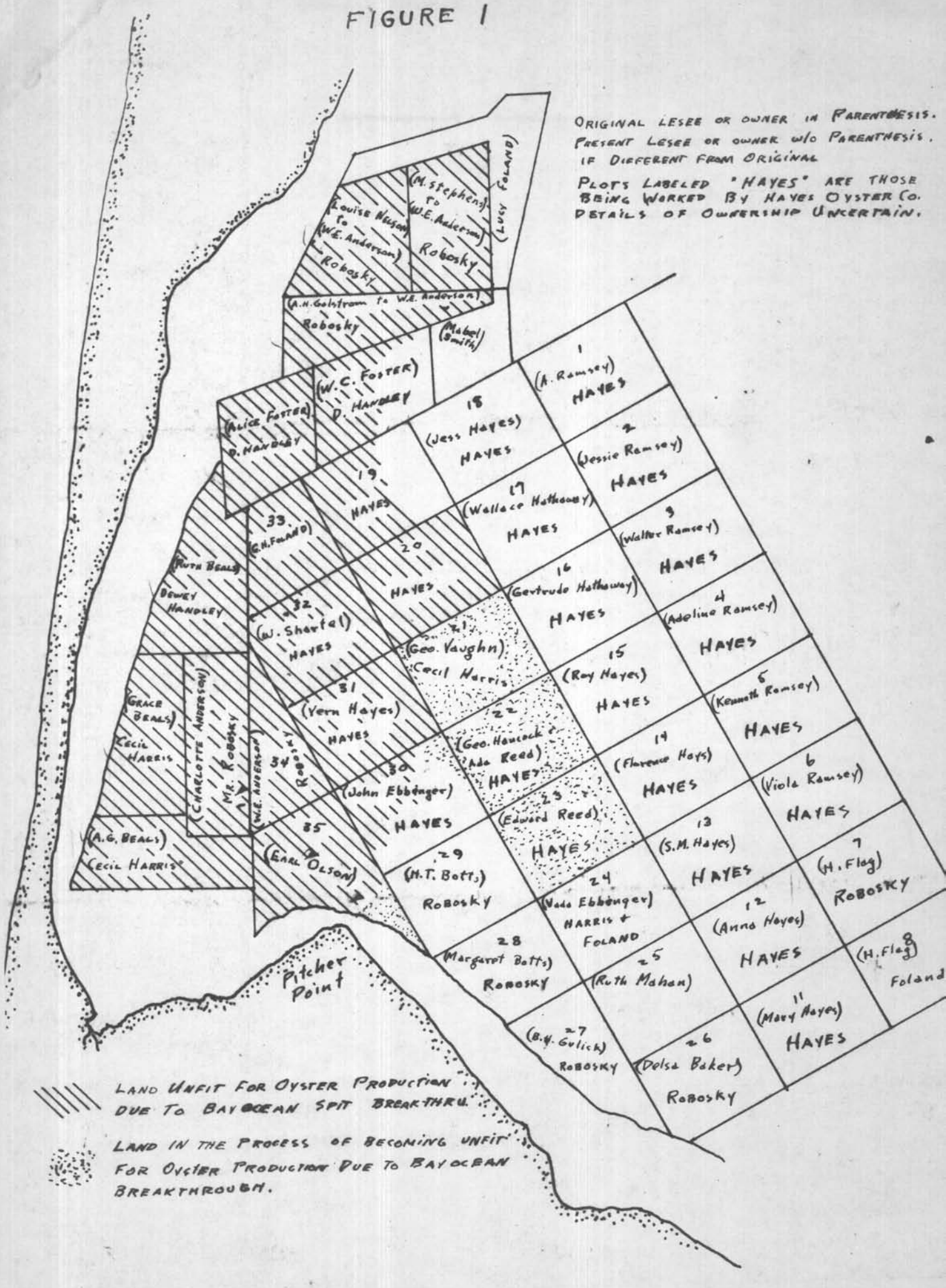
Acreage	Value/Acre	Land Value	Oysters Lost, in Bushels	Value of Oysters	Total Present Loss	Loss if Dike not Built[3]
Tillamook Oyster Company (Foland and Harris)						
150	$500	$75,000	25,000	($50,000)	$125,000	$934,500
Hayes Oyster Company						
200	($500)	($100,000)	?	?	$100,000[2]	?
Earl Olson						
50	$1,000	$50,000	10,000	$20,000	$70,000	$70,000
Handley's (Ray Thomas, manager)						
125	$750	$93,750	10,000	($20,000)	$113,750	($172,500)
Mr. Robosky						
250	$50-$500 (ave. $275)	($68,750)	4,000	($8,000)	($72,500)	?
775		$387,500	47,000	$94,000	$481,500	

1/ Note: Values in parentheses are not direct quotes from the oyster growers, but are interpolations from similar data.

2/ Note: This figure does not include the loss due to loss of oysters on the claims.

3/ Includes loss of additional ground, oysters and plant equipment if encroachment of sand continues.

FIGURE 1


ORIGINAL LESEE OR OWNER IN PARENTHESIS.
PRESENT LESEE OR OWNER W/O PARENTHESIS.
IF DIFFERENT FROM ORIGINAL
PLOTS LABELED "HAYES" ARE THOSE BEING WORKED BY HAYES OYSTER CO.
DETAILS OF OWNERSHIP UNCERTAIN.
(M. Stephens) to W.E. Anderson
Louise Nelson to W.E. Anderson
Robosky
(Lucy Foland)
(A.H. Golstrom to W.E. Anderson)
Robosky
(Mabel Smith)
(W.C. Foster) D. Handley
(Alice Foster) D. Handley
19 HAYES
18 (Jess Hayes) HAYES
1 (A. Ramsey) HAYES
2 (Jessie Ramsey) HAYES
17 (Wallace Hathaway) HAYES
3 (Walter Ramsey) HAYES
33 (C.H. Foland)
20 HAYES
16 (Gertrude Hathaway) HAYES
4 (Adeline Ramsey) HAYES
(Ruth Beals) Dewey Handley
32 (W. Sherfal) HAYES
21 (Geo. Vaughn) Cecil Harris
15 (Roy Hayes) HAYES
5 (Kenneth Ramsey) HAYES
31 (Vern Hayes) HAYES
22 (Geo. Hancock & Ada Reed) HAYES
14 (Florence Hays) HAYES
6 (Viola Ramsey) HAYES
(Grace Beals) Cecil Harris
(Charlotte Anderson) Mr. Robosky (W.E. Anderson)
34 Robosky
30 (John Ebbinger) HAYES
23 (Edward Reed) HAYES
13 (S.M. Hayes) HAYES
7 (H. Flag) Robosky
(A.G. Beals) (Cecil Harris)
35 (Earl Olson)
29 (H.T. Botts) Robosky
24 (Vada Ebbinger) Harris & Foland
12 (Anna Hayes) HAYES
8 (H. Flag) Foland
28 (Margaret Botts) Robosky
25 (Ruth Mahan)
11 (Mary Hayes) HAYES
27 (B.Y. Gulick) Robosky
26 (Delsa Baker) Robosky
Pitcher Point
LAND UNFIT FOR OYSTER PRODUCTION DUE TO BAY-OCEAN SPIT BREAK-THRU.
LAND IN THE PROCESS OF BECOMING UNFIT FOR OYSTER PRODUCTION DUE TO BAY-OCEAN BREAKTHROUGH.