FINDINGS OF COMPLIANCE
DREDGED MATERIAL DISPOSAL ACTIVITIES

PHYSICAL AND CHEMICAL ANALYSIS FOR SEDIMENTS FROM THE
TILLAMOOK BAY FEDERAL NAVIGATION PROJECT

December 1980

1. Synopsis. Sediment samples were obtained for elutriate, chemical and physical analyses from five locations in the Garibaldi Boat Basin access channel. Water was collected from the area adjacent to the upland disposal site and chemically analyzed for comparison with navigation channel eluates.

BACKGROUND

2. Tillamook Bay is located on the northern Oregon coast, approximately 75 miles west of Portland (figure 1). The estuary is 3 miles wide and 6 miles long. It is supplied with freshwater by five rivers, draining an area of 533 square miles, and is the second largest estuary in the state.

3. The diurnal tidal range in the estuary is 5.7 feet with an extreme of 7.5 feet. Tidal influences extend up the five rivers to varying distances, depending on the gradient of each stream (0.4 and 7.0 miles upstream on the Miami and Tillamook Rivers, respectively).

4. The U.S. Army Corps of Engineers is responsible for maintaining a 5,700-foot-long north jetty and an 8,000-foot-long south jetty. Additionally, the Corps provides a channel 18 feet deep and 200 feet wide from deep water to Miami Cove, and an approach channel, 12 feet deep, leading into the Garibaldi Boat Basin. Since 1966, most of the entrance channel has been maintained by the scouring action of tidal currents. The channel in front of the boat basin

(river mile (RM) 3+00 to 3+26) is subjected to eddy currents from tidal action and the sediments transported downstream by the Miami River settle in the channel. Consequently, the area has been dredged seven times since its completion in 1958.

5. Sediments are being deposited in the estuary at an estimated rate of 135,000 tons annually, and the estuary is now believed to be about 40 percent of its original size. Erosion of the drainage basin following major fires has contributed to this filling.[1]

6. The Tillamook Bay channel near Garibaldi is scheduled to be dredged again in 1981. Approximately 35,000 cubic yards of material will be removed with a small pipeline dredge. It is proposed that two, contiguous, upland sites be used as disposal sites for the dredged material (figure 1). These sites have been used for upland disposal since 1958 and were recently improved with the construction of dikes and weirs with a maximum 3-inch water overflow.

7. Section 404 of the Clean Water Act, EPA guidelines (40 CFR 230), and Portland District, Corps of Engineers' guidelines specify that sediment from the dredging and disposal sites must be evaluated prior to dredging to determine if significant physical, chemical, or biological impacts will result from disposal operations. If sediment consists of fine-grained material (i.e., 20 percent by weight of particles smaller than 0.074 mm in diameter) and contains more than 6 percent organic material or volatile solids, chemical data is obtained to determine if harmful levels of contaminants are present.[2]

8. Areas of particular concern in regards to disposal operation impacts are parks, national and historical monuments, national seashores, wilderness areas, research sites, municipal and private water supplies, fisheries, sanctuaries, refuges, wetlands, mudflats, recreational areas, and vegetated shallows. Also of concern are a disposal project's impacts on esthetics.

9. There are ten, recognized natural areas in the immediate vicinity of Tillamook Bay.[3] All of these are located on the open coast or upper bay areas and are not directly affected by the navigation project. However, the navigation channel is bordered by wetlands containing mudflats and vegetated

shallows. These areas are used extensively by migrating waterfowl and other types of shorebirds. They contain commercial oyster rearing areas, extensive eelgrass beds, herring spawning areas, hardshell and softshell clam habitat, and Dungeness crab nursery areas. Additionally, the navigation channel and surrounding areas are used for recreational purposes including crabbing, fishing, clamming, and waterfowl hunting.

10. Major industries around the bay are those connected with timber, agricultural products, fish and seafoods, and tourism.[1] Primary point source polluters surrounding the navigation channel at Garibaldi include three fish processing plants, one wood products plant, and one municipal sewage plant.

11. Ten, historic, Indian village sites have been identified around Tillamook Bay.[4] One is located adjacent to the navigation channel but is completely covered by the present city of Garibaldi.

12. Initial surveys indicated that the navigation channel near Garibaldi, Oregon, contained sediment with more than 20 percent silt/clay and more than 6 percent organic material. Since these percentages exceeded guideline values, a sampling program was undertaken to assess the physical and chemical characteristics of the sediment.

METHODS

13. Sediment samples for elutriate tests were collected at five locations in the navigation channel in and around the Garibaldi Boat Basin between RM's 3.0 and 3.4. The entrance to the navigation channel (RM 0 to 3.0) is predominantly sand (figure 2) and does not require chemical analyses. The channel between the entrance and boat basin is maintained by the scouring action of swift currents and does not require dredging.

14. A Ponar grab sampler attached to a hand-operated winch was used to collect sediments. Samples were released into an acid-cleaned, stainless steel pan before being transferred to 2-5/8-inch-diameter, 2-foot-long, acid-cleaned core liners. The liners are made of transparent cellulose butyrate

acetate and were sealed with polyethylene caps. The full core liners were stored in ice for transport to the analytical laboratory.

15. Sediments to undergo physical and benthic analyses were also sampled with the Ponar sampler. The benthos samples were sieved through 30-mesh wire. The retained fraction was preserved with formaldehyde and stored for future analysis if such is desired. Sediments were stored in 1-quart, plastic jars and sent to the Division Materials Laboratory for physical analysis.

16. The chemical analyses were performed by the U.S. Geological Survey (USGS) using the methods detailed in their publication, "Native Waters, Bottom Material and Elutriate Analyses of Selected Estuaries and Rivers in Western Oregon and Washington."[5] These methods were coordinated with and are approved by the U.S. Environmental Protection Agency.

17. Elutriate analyses were performed using estuarine water collected at station 4, adjacent to the upland disposal site. The water was collected with a Van Dorn water sampler at a depth of 2 meters. This water was placed in collapsible polyethylene containers and stored with ice during transport to the laboratory.

18. A Hydrolab 8000 water quality testing instrument was used to measure dissolved oxygen, pH, oxidation/reduction potential (ORP), conductivity, and temperature at the various sampling sites near Garibaldi, Oregon, on 16 December 1980.

RESULTS

19. Physical Characteristics. The physical characteristics of sediments collected in Tillamook Bay are presented in table 1 and figures 2 and 3. The void ratio ranged between 0.8 and 3.7 indicating that sediments were moderately to highly porous. The percent volatile solids is a measure of combustible organic material. Sediments from stations 4-6 contained 7.5 to 11 percent volatile solids levels, which exceed the Corps' guideline of 6 percent. The density of sediments ranged between 2,667 to 2,782 g/l which are

median values. The roundness grade estimates the angularity of material. Generally, angular material resists displacement and is closer to its point of origin than more rounded material. Stations 3-6 contained angular to subangular sediments. Station 2, which was located outside the basin in an area scoured by swift currents, consisted of subangular to subrounded material.

20. The grain size distribution curves for the Tillamook navigation channel at Garibaldi show that sediments were composed of well-graded silt/clay (52 to 60 percent). Station 4, located within the mooring basin, contained 83 percent silt and clay. Station 2 contained uniformly-graded, fine sand with no silt or clay.

21. The grain size distribution curve for the entrance channel indicates that sediments are composed of medium to fine sand with no silt or clay.

22. Chemical Characteristics.

a. Water Quality. Data collected on water quality are presented in table 2. The temperature and pH were within normal ranges at all sampling stations. The dissolved oxygen concentration was saturated throughout the water column. Measurements were taken during an outgoing tide when salinity is decreasing. Conductivity ranged between 30.4 to 49.7 mmho/cm (18.8 to 32.5 ppt salinity). Turbidity was minimal (1.0-2.8 NTU). The ORP indicated normal, oxidizing conditions at stations 2, 3, and 5. ORP values at stations 4 and 6 were slightly depressed. All parameters measured indicated that water quality was very good and within established guidelines.

b. Chemical Analyses. Chemical analyses for elutriate and water samples collected at the Tillamook navigation channel near Garibaldi are presented in table 3. Results from bulk sediment analyses are presented in table 4. There are no water quality guidelines that apply to estuarine conditions. EPA guidelines are promulgated for freshwater or marine environments. Generally, the freshwater guidelines are more stringent than the marine criteria. Taking a conservative approach, the results reported here are compared to both EPA freshwater and marine guidelines.[6,7,8] These guidelines provide for the protection and propagation of fish and other aquatic life and for recreation in

accordance with the 1983 goals of Public Law 92-500. EPA guidelines are not established for all the substances measured. In these cases, the results are compared to guidelines established by Portland District, Corps of Engineers.[2] It should be remembered that the various guidelines are not rigid standards and are used for purposes of comparison. Substances which exceeded the guidelines (contaminants of concern) are manganese, nitrogen (ammonia), and phenols.

c. Manganese was released at concentrations ranging from 660 to 890 ug/l. The ambient level measured in the receiving water sample was 40 ug/l. The freshwater guideline is 50 ug/l and applies only to drinking water. The marine criterion is 100 ug/l and applies only to consumers of mollusks. Manganese is a micronutrient which rapidly precipitates out of the water column and is relatively nontoxic.

d. Nitrogen (ammonia). The concentration of ammonia in estuarine eluates ranged between 1.5 and 3.3 mg/l. Ammonia dissolves in water to un-ionized (NH_3) and ionized (NH_4) species. The un-ionized form is toxic in freshwater and its relative concentration is dependent on pH and temperature. Conditions at the upland disposal site suggest that the supernatant overflowing into Tillamook Bay would contain an initial concentration of ammonia ranging between 0.04 and 0.09 mg/l. This exceeds the ambient level of 0.001 mg/l and the freshwater guideline of 0.02 mg/l. The higher-than-ambient ammonia concentration would cause a short-term impact to water quality followed by rapid dilution.

e. Phenols. The concentration of phenols ranged between 4 and 73 ug/l in boat basin eluates compared with 2 ug/l in the receiving water sample. The concentration of phenols in the eluate samples exceeded the 1976 EPA guidelines[6] for phenolic compounds (1 ug/l). However, new guidelines,[7] ranging between 30 and 500,000 ug/l, have been published which delineate between a variety of phenolic compounds. The most toxic of these are anthropogenic, chlorinated phenols. High background levels of 100 to 200 ug/l for phenols in eluate samples are characteristic of the Pacific Northwest and are associated with the logging industry. It is probable that phenols released from the sediment samples resulted from wood processing activities and chlorinated phenols are present in only insignificant concentrations.

f. Bulk Sediment Analyses indicated that Tillamook Bay navigation channel sediments contain moderately high amounts of arsenic, copper, iron, and nickel, and relatively heavy concentrations of cadmium and phosphorus. The bulk sediment analysis gives an indication of indigenous substances that can potentially become soluble. However, it must be remembered that this analysis measures the total level of constituents in sediment, including the chemically unavailable and mineralogically-bound components. The fact that these elements do not exceed guideline levels in elutriate analyses indicates that they are tightly bound to the sediments and would not be released during disposal of dredged material.

DISCUSSION

23. The Tillamook navigation channel at Garibaldi, Oregon, contains sediments which consist of 52 to 83 percent silt and clay. The dredging and disposal of this material could result in resuspension of the fine-grained materials into the water column causing high turbidity, transport of material outside the disposal area, reduction in light penetration, covering of benthic organisms (at inwater or ocean disposal sites), and the creation of unesthetic conditions. The degree to which these factors will impact the environment depends upon the disposal method. It is proposed that the dredged sediments be placed in existing upland disposal sites. This would have a positive impact because it would remove any contaminants from the aquatic ecosystem. The diked, upland disposal sites have been used in previous years and there is no existing vegetation which would be destroyed or covered. However, if supernatant water is allowed to flow unchecked back into the bay, short-term impacts are possible. Suspended, fine-grained material could enter the water column and disperse over a large area before settling. Tillamook Bay is one of the most productive clam areas in the Pacific Northwest and the dredged material could cause siltation in clam beds adjacent to the upland sites. Additionally, eelgrass beds, crab nursery areas, and herring spawning areas are present along the navigation channel which could be adversely affected by both siltation and reduced light penetration. These impacts would be negligible if overflow water is monitored and/or regulated to reduce turbidity.

24. An alternative to upland disposal is ocean dumping at a designated ocean disposal site offshore of Tillamook Bay. This would have the positive impacts of removing fine-grained material from the estuary and thus minimize physical impacts to estuarine aquatic plants and organisms. The greater water volume available for dilution at an ocean site would quickly dissipate suspended, light-weight dredged sediments. This alternative would require bioassays because sediment in the Garibaldi Boat Basin access channel contains a higher percentage of silt and clay than allowed by Federal regulations.

25. Chemical analyses show that manganese, nitrogen (ammonia), and phenols will initially be released in concentrations which exceed both ambient and guideline levels. Manganese is highly soluble and is frequently released in significant concentrations during elutriate tests.[9] This is the result of reduction of the insoluble, oxidized manganese to a soluble manganese (II) with decreasing pH, ORP, and oxygen such as occurs in sediment samples prior to elutriation. During disposal of dredged sediments, manganese readily combines with oxygen to form MnO_2 which rapidly precipitates out of the water column. The tolerance levels of aquatic organisms are quite high, ranging between 1,500 and 1,000,000 ug/l. Additionally, it should be noted that the marine criteria of 100 ug/l of manganese for consumers of marine mollusks appears to be invalid. This guideline has been seriously questioned[10] and no case of human poisoning due to consumption of manganese-enriched mollusks is known. For these reasons ocean and upland disposal of dredged sediments is expected to cause insignificant, short-term water quality impacts.

26. Ammonia was present in eluates at levels only slightly above guideline values (.09 versus .02 mg/l). This initial concentration would rapidly decrease to levels below the guideline upon mixing with the receiving water during ocean or upland disposal activities. Therefore, no significant, ammonia-related impacts are expected.

27. The initial concentration of phenols in the water column will be greater than background levels upon the disposal of Tillamook Bay sediments dredged from the boat basin area. As previously mentioned, high ambient concentrations of phenols are common in the Pacific Northwest and it is unlikely that toxic, chlorinated phenols are present in significant amounts. However,

a study is currently being conducted to determine if harmful types of phenolic compounds are being released from dredged sediments. Until further information becomes available, it is difficult to adequately assess phenolic-related impacts. If naturally occurring phenols are being released then they are subject to rapid biological degradation in addition to dilution during disposal activities. The initial concentration released from dredged sediments will have a short-term impact on water quality and quickly diminish to levels below guideline values.

28. Elutriate tests aid in the assessment of short-term impacts on water quality. However, they do not provide information on long-term impacts. Bulk sediment analyses have limited value as indices of long-term impacts. In the case of Tillamook Bay, bulk sediment tests indicate that sediments contain moderately high amounts of arsenic, copper, cadmium, iron, nickel and phosphorus. With the exception of phosphorus, these substances did not become soluble during elutriate tests. However, they are present in the sediments and are subject to dispersal during and after dredging. The distribution of these substances, particularly arsenic and cadmium, in the form of fine-grained, particulate dredged material could have long-term impacts on aquatic plants and animals. For example, uptake into clam tissues, especially deposit feeding species, is possible. However, since current procedures are designed to measure short-term effects, an assessment of long-term impacts is largely speculative. Upland disposal of dredged sediments will remove potentially harmful substances from direct contact with the water column and aquatic organisms.

29. An evaluation of contaminants of concern does not quite present an accurate account of the sediment and water quality conditions at the Garibaldi boat basin. As mentioned earlier, the boat basin area has several fish processing plants and a sewage treatment facility which discharge their wastes into the bay. The affect of these discharges is readily reflected in the nutrient levels of the water column. The ambient phosphate phosphorous concentration is 377 ug/l. This is the highest level measured at any of the navigation projects sampled to date. Bulk sediment analyses show that sediments contain 1,000 mg/kg total phosphorous; an extremely high value. The concentration of dissolved nitrogen was moderate but the organic nitrogen

concentration present in the sediments was 1,600 mg/kg; again, extremely high. Amounts of carbon in the water column and sediment were within normal ranges. There are no Federal or State guidelines which apply to nutrient levels and, therefore, the concentrations listed here are not considered excessive and would not necessarily be detrimental to water quality during disposal activities. However, the discussion serves to point out that water and sediment near the Garibaldi Boat Basin are highly enriched.

CONCLUSIONS

30. Upland disposal of Tillamook Bay dredged sediments is expected to cause suspension of fine-grained material and an initial concentration of manganese, ammonia, and phenols which exceed ambient levels. Increased turbidity will be the most significant impact which, in turn, can affect aquatic plants and animals in the estuary. The impact of turbidity can be controlled by monitoring and/or regulating the overflowing water at the proposed upland disposal site. The chemical substances are relatively nontoxic and will rapidly be diluted or precipitated out of the water column. Therefore, only short-term, insignificant changes in water quality are expected.

31. Ocean disposal of sediments from the mouth of Tillamook Bay (RM 0.0) is not expected to cause adverse impacts because this material is sand and meets exclusion criteria for ocean disposal.

32. Ocean disposal of sediments from the Garibaldi Boat Basin access channel (RM 3.0 to 3.4) is expected to have impacts similar to those discussed for upland disposal. However, because a high proportion of this material is silt and clay, it does not meet exclusion criteria for ocean disposal and bioassays would be required.

RECOMMENDATIONS

33. A Finding of Compliance with the requirements of the "Guidelines for Specification of Disposal Sites for Dredged or Fill Material"[7] is recommended

for disposal operations of dredged material from the Tillamook Bay Federal navigation channel near the Garibaldi Boat Basin under the conditions discussed below.

34. Dredged sediment at the mouth of Tillamook Bay (RM 0.0) is composed of sand and thus complies with the exclusion criteria in Section 103, Marine Protection, Research, and Sanctuaries Act of 1972. This material can be dumped at EPA-designated, interim ocean disposal sites.

35. Dredged sediment in and near the boat basin is predominantly silt and clay with evidence of anthropogenic contamination, and therefore, is not in compliance with exclusion criteria set forth in Section 103, Marine Protection, Research, and Sanctuaries Act of 1972. Prior to ocean disposal of this material, bioassays would have to be performed to determine whether significant impacts would occur. Chemical and physical analyses suggest that ocean disposal would result in few physical or chemical impacts.

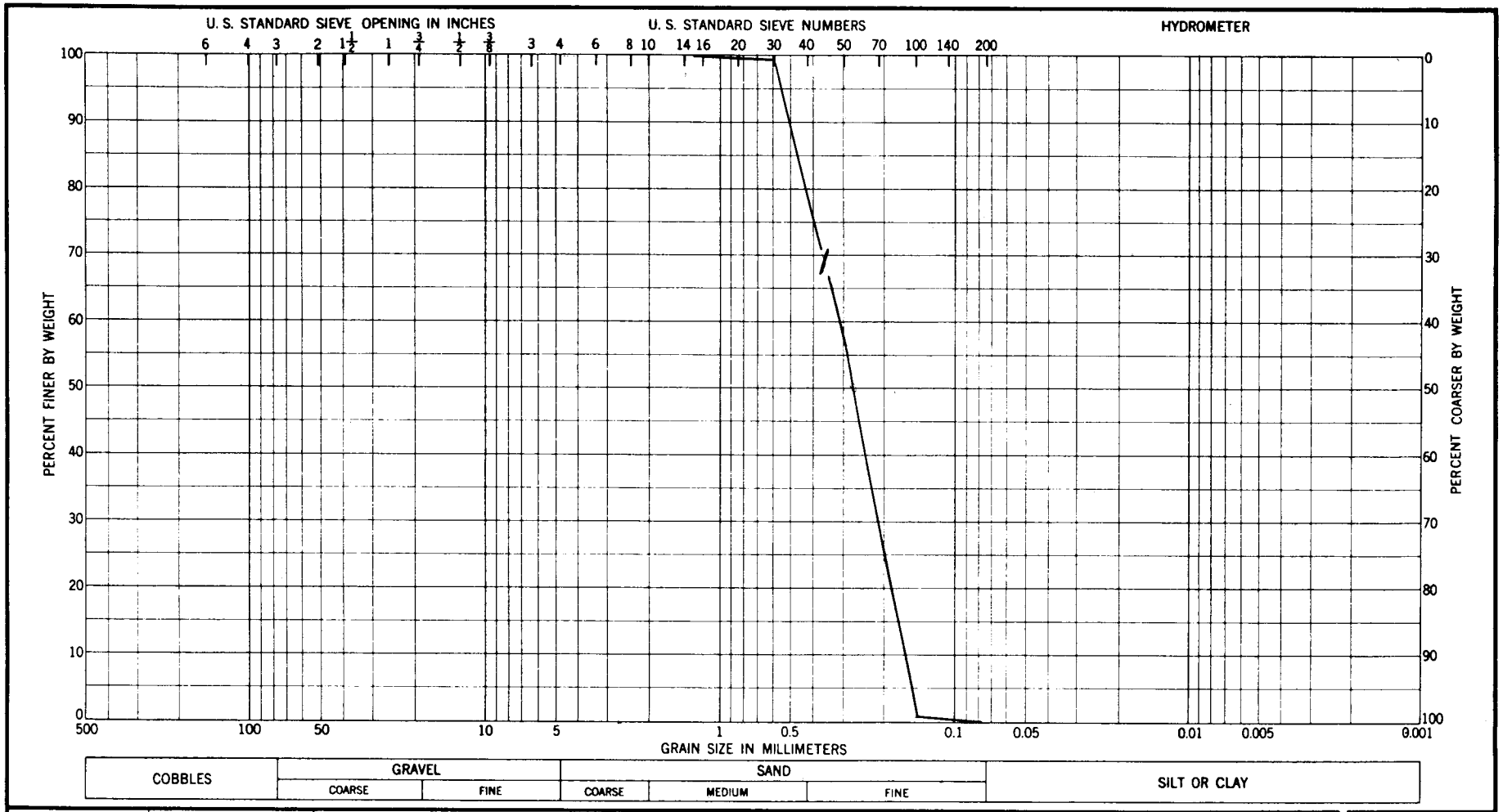
36. Disposal of boat basin sediments at the upland sites designated in figure 1 is recommended. Supernatant and receiving water should be sampled periodically during disposal to measure turbidity. If turbidity levels exceed 50 NTU above background levels, outflow should be blocked and the suspended material allowed to settle. Alternatively, a flocculant could be used to reduce turbidity.

37. Disposal sediments would have no significant impact on wildlife sanctuaries and refuges, municipal and private water supplies, national seashores, parks and historic monuments, wilderness areas, research sites, water-related recreation, and threatened or endangered species. Excessive turbidity could have minor, short-term impacts on the surrounding wetlands, mudflats, vegetated shallows, crab and clam fisheries, and esthetic conditions as a result of siltation and reduced light penetration.

38. Bottom sediments between channel miles 0.5 and 3.0 have not been sampled since 1962. The high current velocity, visual inspection, and grain-size distribution curve at station 2 all indicate that this part of the navigation channel contains only sand and should meet exclusion criteria for ocean and

inwater disposal of dredged sediments. However, before dredging is conducted in this area, sediment samples should be collected to verify that sediments are predominantly sand.

Figure 1. Aerial photograph of the Tillamook Bay Federal navigation channel near Garibaldi, Oregon showing sampling sites and upland disposal sites (shaded area represents dredged portion of channel).



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	Entrance Bar Mile -0+50+00	SAND (SP)				

GRADATION CURVES

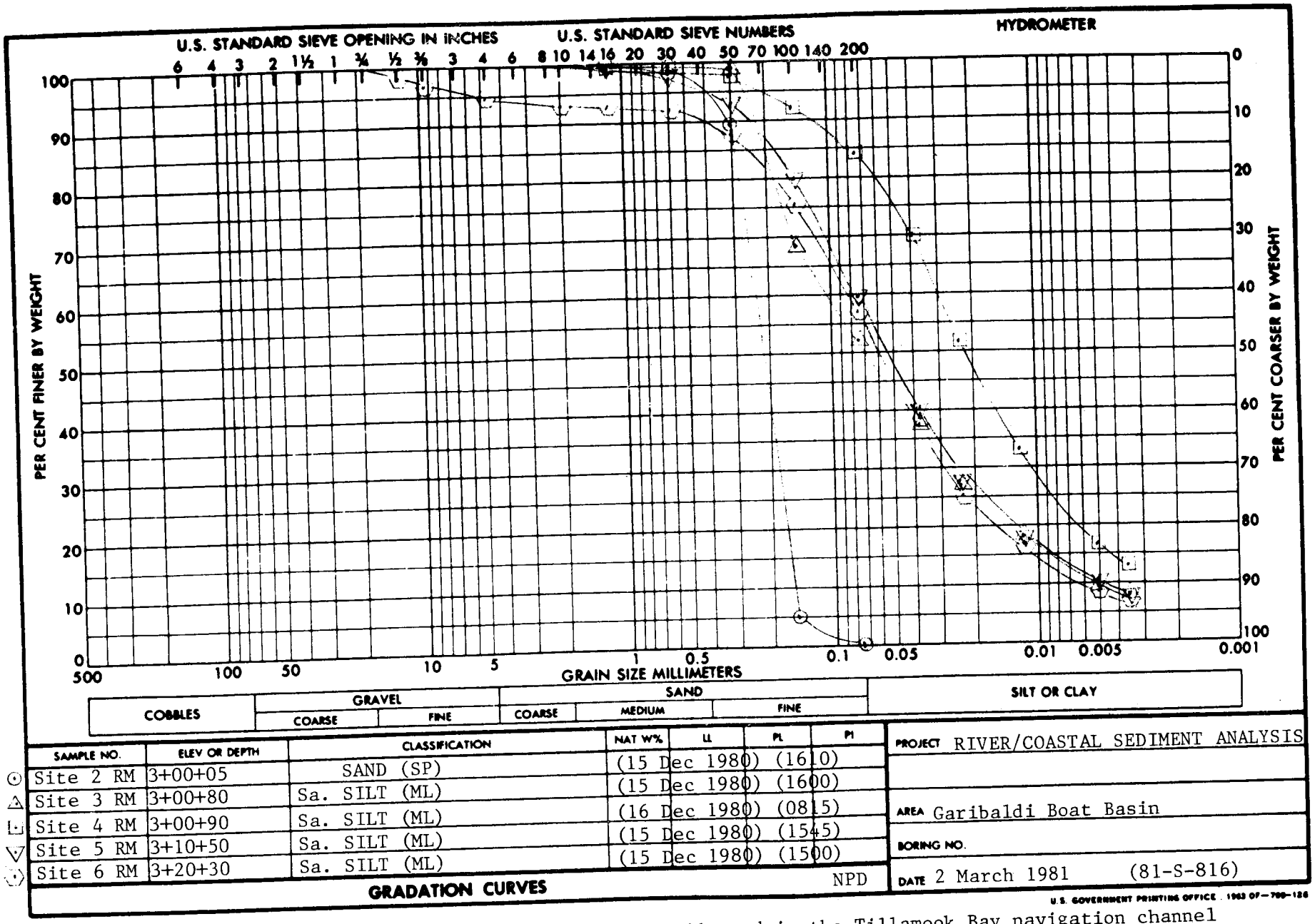
Project Tillamook Bay

Area

Boring No.

Date 29 June 76

Figure 2. Grain size distribution curve for sediment collected at the mouth of the Tillamook Bay Federal navigation project.



	SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
⊙	Site 2 RM	3+00+05	SAND (SP)	(15 Dec 1980) (1610)			
△	Site 3 RM	3+00+80	Sa. SILT (ML)	(15 Dec 1980) (1600)			
□	Site 4 RM	3+00+90	Sa. SILT (ML)	(16 Dec 1980) (0815)			
▽	Site 5 RM	3+10+50	Sa. SILT (ML)	(15 Dec 1980) (1545)			
◇	Site 6 RM	3+20+30	Sa. SILT (ML)	(15 Dec 1980) (1500)			

GRADATION CURVES NPD

PROJECT RIVER/COASTAL SEDIMENT ANALYSIS

AREA Garibaldi Boat Basin

BORING NO.

DATE 2 March 1981 (81-S-816)

U.S. GOVERNMENT PRINTING OFFICE : 1963 O-700-126

Figure 3. Grain size distribution curves for sediments collected in the Tillamook Bay navigation channel near Garibaldi, Oregon.

Table 1.

NPDEN-GS-L(81-S-816)

RIVER/COASTAL SEDIMENT ANALYSIS

GARIBALDI BOAT BASIN

Sample Identification	Specific Gravity of Water	Density of Matl. in place gms/liter	Density of Median Solids gms/liter	Void Ratio	% Volatile Solids	Roundness Grade
Site 2 RM 3+00+05 23' (1610) 15 Dec 1980	1.0223	1973	2693	0.758	1.21	Subangular to Subround
Site 3 RM 3+00+80 (1600) 15 Dec 1980	1.0213	1608	2728	1.910	4.76	Angular to Subangular
Site 4 RM 3+00+90 in channel 11' (0815) 16 Dec 1980	1.0223	1376	2667	3.655	11.02	Angular to Subangular
Site 5 RM 3+10+50 (1545) 15 Dec 1980	1.0086	1483	2755	2.678	7.45	Angular to Subangular
Site 6 RM 3+20+30 6' (1500) 15 Dec 1980	1.0225	1568	2782	2.225	8.00	Angular to Subangular
Entrance Bar RM -0+50+00 29 June 1976	1.0215	2038	2709	0.661	0.59	Subrounded to Subangular

TABLE 2

WATER QUALITY DATA MEASURED AT TILLAMOOK BAY FEDERAL NAVIGATION PROJECT NEAR GARIBALDI, OR

DATE: 16 Dec 80 **SAMPLING PERSONNEL:** U'Ren, Livingston

WEATHER CONDITIONS: Beautiful, 53°F, Low tide at 1430 hours

COMMENTS: (Wildlife, vessel traffic, completion status of training jetty, sampling gear difficulties, sampling vessel, etc.) Many different kinds of ducks, but predominantly Mallards.

Very swift outgoing tide (5 knots), difficult to stay at Station 2 long enough for a sample.

Station	2 (Mile 3+00+05)		3 (Mile 3+00+80)		4 (Mile 3+00+90)		5 (Mile 3+10+50)		6 (Mile 3+20+30)	
Parameter	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
Depth (ft.)	20'		11'		11'		9'		7'	
Dissolved Oxygen (mg/l)	11.04	10.90	10.75	10.80	10.84	10.76	10.64	10.59	10.70	10.67
Conductivity (mmho/cm)	30.4	44.3	36.8	49.1	39.0	49.4	47.4	49.5	48.5	49.7
Salinity										
ORP	253	248	242	241	188	194	233	211	205	190
Temperature (°C.)	9.8	10.5	10.0	10.9	10.2	10.8	10.8	10.9	10.9	10.9
pH	8.15	8.15	8.20	8.24	8.18	8.25	8.17	8.17	8.17	8.23
Turbidity (NTU)	1.3	1.8	1.8	2.6	1.7	2.8	1.7	2.0	1.0	1.7
Time		1135	1136	1138		1155	1141	1145	1148	1152

Collected receiving water from Station 4.

Table 3. Results of elutriate tests from sediments collected from the Garibaldi Boat Basin at Tillamook Bay, Oregon.

PARAMETERS	RECEIVING WATER (STATION 4)	STATION 3	STATION 4	STATION 5	STATION 6	MARINE GUIDE-LINES	FRESHWATER GUIDE-LINES
ARSENIC, UG/L	0		2			508	440
BARIUM, UG/L	1		100				1,000
BERYLLIUM, UG/L	10		0				130
CADMIUM, UG/L	0	0	0	1	0	59	1.5
CARBON, ORGANIC MG/L	3.3	11	12	12	11		
CHROMIUM, UG/L	0	0	0	0	0	44	2,200
COPPER, UG/L	0	0	0	3	0		12
CYANIDE, UG/L	1		2			30	52
IRON, UG/L	100	130	400	170	150		1,000
LEAD, UG/L	2	1	0	0	0	668	74
MANGANESE, UG/L	40	890	750	810	660		
MERCURY, UG/L	0	0	0	0	0	3.7	.0017
NICKEL, UG/L	0		0			140	1,100
NITROGEN, AMMONIA MG/L	.05	3.3	1.5	1.8	1.8		.02
NITROGEN, ORGANIC MG/L	.05		.9				
PHENOLS, UG/L	2	30	73	4	46		
PHOSPHORUS, TOTAL UG/L	377		228				
ORTHOPHOSPHATE,UG/L	52	40	85	49	55		
ZINC, UG/L	40	40	40	40	40	170	180
ALDRIN, UG/L	0		0			1.3	3
AMETRYNE, UG/L	0		0				
ATRATONE, UG/L	0		0				
ATRAZINE, UG/L	0		0				
CHLORDANE, UG/L	0		0			.09	2.4
CYANAZINE, UG/L	0		0				
CYPRAZINE, UG/L	0		0				
DDD, UG/L	0		0				
DDE, UG/L	0		0			14	1,050
DDT, UG/L	0		0			.13	1.1
DIELDRIN, UG/L	0		0			.71	2.5
ENDOSULFAN, UG/L	0		0			.034	.22
ENDRIN, UG/L	0		0			.037	.18
HEPT EPOX, UG/L	0		0				
HEPTACHLOR, UG/L	0		0			.053	.5
LINDANE, UG/L	0		0			.004	2
METHOXYCHLOR, UG/L	0		0			.03	.03
MIREX, UG/L	0		0			.001	.001
PCB, UG/L	0		0			10	2
PCN, UG/L	0		0				
PERTHANE, UG/L	0		0				
PROMETONE, UG/L	0		0				
PROMETRYNE, UG/L	0		0				
PROPAZINE, UG/L	0		0				
SIMAZINE,UG/L	0		0				
SIMETONE, UG/L	0		0				
SIMETRYNE, UG/L	0		0				
SILVEX, UG/L	0		0			10	10
TOXAPHENE, UG/L	0		0			.07	1.6
2,4-D, UG/L	0		0			100	100
2,4-DP, UG/L	0		0				
2,4,5-T, UG/L	0		0				

TABLE 4

Results of Bulk Sediment Analyses from Samples Collected at Tillamook Bay, inside the Garibaldi Boat Basin (Station 4)

PARAMETERS	LOCATION Station 4	EPA Region V Guidelines
Aldrin (ug/kg)	0.0	--
Arsenic (mg/kg)	6	8 HP*
Barium (mg/kg)	10	60 HP
Beryllium (mg/kg)	1	--
Cadmium (mg/kg)	29	6 HP
Carbon Inorg. (g/kg)	0.6	--
Carbon Org. (g/kg)	26	--
Carbon Tot. (g/kg)	27	--
Chlordane (mg/kg)	0	--
Chromium (mg/kg)	21	75 HP
Copper (mg/kg)	44	50 HP
Cyanide (mg/kg)	0	.25 HP
DDD (ug/kg)	0.0	--
DDE (ug/kg)	0.4	--
DDT (ug/kg)	0.0	--
Dieldrin (ug/kg)	0.0	--
Endosulfan (ug/kg)	0.0	--
Endrin (ug/kg)	0.0	--
Hept Epox (ug/kg)	0.0	--
Heptachlor (ug/kg)	0.0	--
Iron (mg/kg)	27,000	25,000 HP
Lead (mg/kg)	10	60 HP
Lindane (ug/kg)	0.0	--
Manganese (mg/kg)	170	500 HP
Mercury (mg/kg)	0.03	1 HP
Mirex (ug/kg)	0.0	--
Mthxyclr. (ug/kg)	0.0	--
Nickel (ug/kg)	30	50 HP
Nitr - NH_4 (mg/kg)	44	200 HP
N. NH_4 + Org. (mg/	1,600	--
PCB (ug/kg)	5	10,000 HP
PCN (ug/kg)	-	--
Perthane (ug/kg)	0.0	--
Phosph. Tot-P (mg/kg)	1,000	650 HP
Silvex (ug/kg)	0	--
Toxaphene (ug/kg)	0	--
Zinc (mg/kg)	56	200 HP
2,4-D (ug/kg)	0	--
2,4-DP (ug/kg)	0	--
2,4,5-T (ug/kg)	-	--

* HP - Sediments with concentrations exceeding this value are considered "heavily polluted."

Table 5. Garibaldi Boat Basin Field Notes

Purpose of Sampling 404 Pre -dredging survey

Date 15 Dec 80 Wind 1-2 mph

Water Conditions (Wave heights & Direction, Tides, Currents) Calm, High tide at 1335

Weather Beautiful 55° F Sampling Vessel 14' Aluminum Boat

Sampling Personnel U'Ren, Livingston Sampling Gear Ponar, Ellard

Analytical Laboratory

Comments (Wildlife, Sampling Difficulties, etc.)

Station	Depth	Sampling Time	Sampling Methodology	Sampling Description
1 - 50 yards West of Sewage outfall (R.M. 2+40+80)				
2 - In front of Promontory between sewage outfall and Cannery Dock (3+00 +05)				
3 - 25 yrds West of Mooring Basin entrance (3+00+80)				
4 - Mooring Basin entrance channel (3+00+90 - in entrance channel)				
5 - 100 yards east of mooring basin entrance (3+10+50)				
6 - 10 yrds from the end of the dredged area (3+20+30)				
6	8'	1500	Ponar - 'A' sample	Med. Sand
6	8'	1515	Ellard - size	
5	6'	1530	Ponar - 'A' sample	Silt Sand
5	6'	1545	Ellard - size	Sand and a lot of eel grass + eel grass root material. Probably contributed to high organic levels in previous size sample. The eel grass surrounds the upper channel area.

Conclusions (Is sampling completed? Was sampling method adequate? Considerations for future sampling at the project)

FIELD REPORT

Garibaldi Boat Basin

Purpose of Sampling

Date 15 Dec. 80 Wind

Water Conditions (Wave heights & Direction, Tides, Currents)

Weather Sampling Vessel

Sampling Personnel Sampling Gear

Analytical Laboratory

Comments (Wildlife, Sampling Difficulties, etc.)

Station	Depth	Sampling Time	Sampling Methodology	Sampling Description
3	12'	1545	Ponar - A	Silt - clay
3	12	1600	Ellard - size	same leaves
1	30'	1600	Ponar - No sample	Dropped ponar 6 times but only brought
				up 8-10 large bivalve shell fragments. Area too
				coarse for ponar
1	30	1615	Ellard - No sample	Pulled Ellard for several minutes and brought up
				1 medium size rock
2	25'	1630	Ponar - size only	Dropped Ponar 5 times at various distances from
				shore and toward sta. 3. Brought up small shell
				fragments and a small amount of coarse sand which
				was enough for a size samples. Sediment too coarse
				for the ponar.

Conclusions (Is sampling completed? Was sampling method adequate? Considerations for future sampling at the project)

FIELD REPORT

Garibaldi Boat Basin

Purpose of Sampling

Date 16 Dec 80 Wind

Water Conditions (Wave heights & Direction, Tides, Currents) Low tide 1430, Tide going out at start of sampling (0830) with fast current

Weather Clear warm Sampling Vessel

Sampling Personnel Sampling Gear

Analytical Laboratory

Comments (Wildlife, Sampling Difficulties, etc.)

Station	Depth	Sampling Time	Sampling Methodology	Sampling Description
4	11'	0800	Ponar - B analysis	Required 5 drops to get sample, sediment was
			2 cores	black with consistency at soft jello, fuel
				dock was 25 yds from site.
4	11'	0815	Ponar - size	
4	11'	0830	Ponar - benthos	black sample with a full quart of very fine wood
				fibres
6	14'	0940	Ponar - benthos	Required 4 drops, mostly wood fibre
3	20'	1000	" "	wood fibre
5	12'	1015	" "	" "
2	Dropped	Ponar 2 more times	but the sediment was too dense or coarse to obtain a sample	
19 Dec. 80	In size samples 3,4, &5, there are polychaete worms & a dense population of copepods.			

Conclusions (Is sampling completed? Was sampling method adequate? Considerations for future sampling at the project)

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