FINDINGS OF COMPLIANCE

DREDGED MATERIAL DISPOSAL OPERATIONS

BAKER BAY FEDERAL NAVIGATION PROJECT

July - August 1980

1. Synopsis. Sediment samples were obtained for elutriate, bulk sediment, chemical, benthic, and physical analyses from the west navigation channel in Baker Bay, Washington, at channel miles (CM) 2.04, 2.89, and 3.07 on 23 and 24 July 1980. Additional sediment samples were collected in July and August from inwater sites which have been used for disposal of sediments dredged from the navigation channel. Water samples from the Columbia estuary and from the ocean were collected and chemically analyzed for use in the elutriate tests and for comparison with the elutriate data. Determinations of the impacts of discharging sediments dredged from the navigation channel onto the disposal sites were made.

BACKGROUND

2. Baker Bay is located on the north side of the Columbia River estuary between river miles (RM) 3 and 7. A navigation channel extends from approximately RM 3 into Baker Bay, past the west side of Sand Island up to the Ilwaco Boat Basin (figure 1). This channel is 10 feet deep and 200 feet wide for 2,000 feet from the Columbia River channel and then becomes 10 feet deep and 150 feet wide, up to the entrance of the boat basin, a total distance of 3 miles. Another channel extends southeast from the boat basin back towards the Columbia River channel. This East Baker Bay channel is no longer maintained.

3. The direction of the west channel near its mouth has recently been straightened to reduce shoaling. Timber-pile and stone breakwaters have been constructed near its mouth to protect it from excessive wave wash and shoaling.

4. The Corps is responsible for maintaining the authorized project depths in the west channel. Removal of shoaled sediments by the Corps is accomplished by hopper, pipeline, or agitation dredge. Approximately 10,000 to 30,000 cubic yards of material have been removed from the old channel in this manner annually. The dredged sediments were disposed into Environmental Protection Agency (EPA) approved disposal sites (figure 1). Disposal site E is located in the ocean and Area D, in the middle of the estuary. In addition, sediments have been sidecast, disposed of on Sand Island, and discharged at three sites located adjacent to and opposite the Ilwaco Boat Basin.

5. The majority of the sediments dredged in the West Baker Bay channel in the past have been classified as fine to medium sand with less than 6 percent organic material. Such sediments are exempt from requirements for biological and chemical analysis by Section 404 (Public Law 92-500).[1] However, sediments from CM 2.0 to the mooring basin were classified silt and clay in physical analyses performed by the Corps as far back as 1973. These latter sediments, in addition to being fine, contain from 5.5 to 8.0 percent organic material.

6. Portland District guidelines specify that sediment to be dredged, if comprised of more than 20 percent sediment with particle sizes smaller than sand or more than 6 percent organic material or volatile solids, must undergo chemical analysis to determine its pollution potential. Sediment samples from the proposed freshwater or estuarine disposal site(s) for the dredged sediments must also be analyzed to aid in assessing impacts of disposal of dredged materials which do not meet the guidelines.

7. Pursuant to the guidelines, samples were collected for chemical analyses on 22-25 July and 19-20 August 1980, from near the proposed

disposal sites and from the west channel at CM 2.04, 2.89, and 3.07. Samples were analyzed for all parameters which would likely be present in the dredged sediments, given the point and nonpoint contaminant sources for the area.

8. High levels of organic material have entered some portions of the Columbia River estuary. The pulp and paper industry is the major contributor. It generates approximately 75 percent of the total waste load;[2] the municipalities contribute about 13 percent; and food processing and miscellaneous industries contribute the remaining 12 percent. In addition, log dumping, rafting, and storage contribute wood materials to the waterways. Current research shows that such log handling can adversely affect water quality.[2]

9. Inorganic wastes are also contributed by the sources discussed above. Also, the shipping, petrochemical, and aluminum-refining industries; grain elevators; forest products plants; woolen mills; agriculture; and dairies contribute to the pollution of the river sediments.

10. The 18 May 1980 volcanic eruption of Mount St. Helens resulted in mudslides which placed millions of cubic yards of sediments and forest debris into the Columbia River system. Ash released from the volcano has washed into the system in large quantities. To date, chemical analyses of both ash and sediments have not shown significant levels of contaminants of concern. Since the sediments and ash continue to wash down into the Columbia River estuary, where portions of it will settle into the proposed dredging and disposal sites, they must be taken into account in estimating impacts from future maintenance activities.

11. The greatest concern in terms of impacts from the Mount St. Helens eruptions is the large amount of fine-grain sediments and ash which have entered the Columbia River and its estuary. Such materials could suspend readily and result in high turbidity during dredging and disposal activities even though chemical contamination by them is not expected. Sediment samples from the Baker Bay navigation channel were taken before and after the Mount St. Helens mudflows. These were compared with each other to estimate increases in fine-grain materials among surface sediment samples.

12. Temperature and radioactivity are the two parameters of most concern in the water quality of the Columbia River, although degradation to some sections of the waterway from specific point or nonpoint sources of other parameters may occur. Temperature usually exceeds optimum levels for salmonids in August but is satisfactory for most of the remainder of the year. Radioactivity is high primarily as a result of discharges by the Hanford Atomic Works upstream of Richland, Washington, and the Trojan Nuclear Power Plant near Rainier, Oregon.[2]

13. In addition to the above parameters, supersaturated levels of dissolved gases have been produced by spilling of dams. This factor can be critical to salmonids by causing the gas bubble disease in them. Despite these various problems, water quality in the Columbia River system is very good (table 3).

14. In the immediate area of the West Baker Bay channel, there are few large sources of contamination. A Coast Guard station is located to the west of the channel at CM .6 and a boat launch is at CM .9 on the same side. The channel ends at the Ilwaco Boat Basin (CM 3.2). This mooring basin and its boat traffic are probably the major sources of contaminants in the area. The City of Ilwaco may also contribute some municipal wastes and by-products from fish processing and ship refitting operations.

15. Turnover of water in Baker Bay is rapid and is influenced by both flows from Columbia River and tides. The river drains an area of 258,000 square miles. The flow at its mouth is highly regulated by dams in the river and ranges from 150,000 to 600,000 cubic feet per second (cfs). The tidal effect on water levels during low riverflow varies from 7 to 8 feet at the mouth of the Columbia River to 1 to 2 feet at Bonneville Dam (RM 207). Riverflow reversal from the tide has been observed as far upstream as Prescott, Oregon (RM 72). Ocean water intrusion may extend as far upstream as RM 20. Salinity in Baker Bay proper ranges from 8 to 31.4 parts per thousand (ppt) on the west side to .5 to 18 ppt on the east side.

16. The stilling effects of tidal action significantly increase the amount of sediment deposited and retained near the mouth and in the estuary of Columbia River. Sources of the sediment include both the ocean and the Columbia River and its tributaries.

17. Federal regulations[12] require evaluation of dredged material disposal impacts to wildlife sanctuaries and refuges, wetlands, mudflats, vegetated shallows, municipal and private water supplies, recreational and commercial fisheries, water-related recreation, esthetics, parks, national and historic monuments, national seashores, wilderness areas, research sites, threatened or endangered species, and the aquatic food web. Disposal operations which may negatively impact any of these special aquatic sites or human use characteristics cannot be performed unless alternative, economically feasible disposal sites are not available and the operations are fully coordinated with concerned private and governmental agencies. If authorized, such disposal operations are to be managed to limit the effects of the disposal. The special sites and uses in the area of the proposed operation are discussed below.

18. Sand Island and the majority of the land to the west of the navigation channel is the Fort Canby Military Reservation, a national historic site. This area is managed by the Washington State Parks and Recreation Commission. It is part of the Cape Disappointment Historic District. A campground is provided for public use in the reservation.

19. Recreational boating and fishing is extensive in Baker Bay and the Columbia River estuary. The main use of the navigation channel is to support related boat traffic.

20. Wetland areas are located to the east of the Ilwaco Boat Basin (disposal site 1 [DS1]) and to the east of Sand Island. Both areas are sites of previously dredged material disposal fills (see figure 1). Eel grass grows sparsely just offshore of the former disposal area as well as offshore of a second, former disposal site located immediately west of the Ilwaco Boat Basin (disposal site 2 [DS2]). Despite the fact that these areas were originally created by dredging activities, they are wetlands and vegetated shallows and as such are protected by Section 404 regulations.[1,12]

21. The ocean disposal site (Area E) is situated such that discharged dredged material could wash onto the nearby public beaches. If discharged materials are significantly different from existing beach sediments, there could be negative esthetic impacts to the beach areas.

22. There are no known wildlife sanctuaries or refuges, municipal and private water supplies, or wilderness areas in the project areas.

23. The estuary has been the object of numerous research studies. The Columbia River Estuary Taskforce (CREST) completed a massive literature search and compilation in 1977 dealing with physical, biological, and cultural characteristics of the estuary.[15] Also in 1977, Morgan and Holton presented 225 bibliographical references for the estuary and documented 8 ongoing research and management programs.[16] The Baker Bay area has been the object of several studies.[15,16,17,18,19] Current research sites in the estuary are unidentified.

24. Bald eagles and snowy plovers are the primary threatened or endangered species of concern in the project area. Bald eagle nest sites have been identified on the Fort Canby Military Reservation and snowy plover populations have been found in the area of DS1.[15] In addition to these two types of birds, a wide range of waterfowl are located in the estuary and Baker Bay is a major concentration area.[16] Principal wintering populations include American widgeon, pintail, mallard and whistling swan. A substantial breeding colony of hybridizing glaucous-winged western gulls is located on Sand Island.[15,17] Several great blue heron rookeries occur in the estuary[17,18] and a pelagic cormorant rookery occurs at North Head.[15,19]

SAMPLING METHODS

25. The sediment samples collected for physical and chemical analyses were obtained with the Corps' 22-foot trihull, FORT STEVENS. This boat was also

used to obtain water samples from the Columbia River estuary, and benthos samples. A 60-foot charter boat was used to collect water from the ocean.

26. Sediment samples collected for chemical analyses underwent both elutriate and bulk sediment chemical analyses. Water samples were used in performing the elutriate tests and were analyzed to provide background data on the water quality at the dredged material disposal sites.

27. When possible, sediments which were sampled for chemical analysis were obtained with a 220-pound, 9-foot-long gravity corer which was equipped to obtain 2-foot cores in detachable, 2-5/8 inch diameter acid-cleaned core liners. The core liners were made of transparent cellulose butyrate acetate and were sealed with polyethylene caps. In shallow areas, inaccessible by the boat, sediments were sampled by hammering the 2-foot, detachable core liners into the sediments by hand.

28. An acid-cleaned, stainless steel core catcher was attached to the mouth of each core liner to facilitate retention of the sediment sample during retrieval of the corer. The core catchers were removed before storing the samples in ice for transport to the analytical laboratory. This sampling method provided relatively undisturbed and well-preserved sediment samples. Upon reaching the laboratory, the samples were extruded, composited, and subsampled for elutriate, bulk chemical, and/or physical analyses.

29. A 9 by 9-inch, 45-pound Ponar grab sampler was used to obtain benthic samples. It was also used at those stations where insufficient sediment was obtained in the core samples to allow subsampling them for physical analyses. The benthic samples were sieved through 30 mesh wire. The retained fraction was then preserved with formaldehyde and stored for future analysis. Benthic data are not presented here.

30. Water samples were obtained with an 8-liter, acid-cleaned Van Dorn water sampler.

31. A Hydrolab 8000 water quality testing system was used to measure dissolved oxygen, pH, oxidation reduction potential, conductivity, and temperature at various sites in Baker Bay, Columbia River, and the ocean (table 4).

ANALYTICAL METHODS

32. The majority of the elutriate and all of the bulk sediment analyses were performed by U.S. Geological Survey (USGS) following the procedures discussed in the U.S. Geological Survey publication, "Native Water, Bottom Material, and Elutriate Analyses of Selected Estuaries and Rivers in Western Oregon and Washington".[11] The exceptions to this are cyanide, phenolics, orthophosphate, and phosphate elutriate analyses. These were performed by the Corps' North Pacific Division Materials Laboratory on eluate provided by USGS using methods described in the 14th Edition of Standard Methods for Examination of Water and Wastewater.[10] All chemical methods used have been coordinated with and approved by the Environmental Protection Agency.

SAMPLING LOCATIONS

33. On 23 July 1980, sediments for the elutriate analyses were collected from the west navigation channel at CM 2.04, 2.89, and 3.07; from the disposal site (DS) east of the Ilwaco Boat Basin (DS1) opposite approximately CM 3.0, 3.09, and 3.19; from the DS west of the Ilwaco Boat Basin (DS2) opposite approximately CM 3.0, 3.09, and 3.13 (west channel); and from just offshore to the north, west, and east of the Sand Island DS (see table 1 and figure 1). On 20 August 1980, five sediment samples were obtained from upstream, downstream, and within the Area D DS opposite approximately Columbia RM's 7.0, 6.0, and 6.6, respectively.

34. Elutriate analyses were performed using freshwater from Columbia RM 18.5 (opposite Tongue Point) or ocean water obtained from 2 miles south of the end of Columbia River south jetty (see table 1). Elutriate testing with the two types of water provides data representative of the extremes in salt content present within Baker Bay given varying tides and riverflows.

35. In addition to the water obtained for elutriate testing, water samples were taken from east of Sand Island; the center of DS1; Columbia River opposite Tongue Point; the ocean; and the center of Area D. These samples underwent standard water quality analyses.

EVALUATION PROCEDURE

36. Elutriate data on the navigation channel sediments are compared to Corps guidelines and to the analytical data on the water and elutriate samples taken at each DS to estimate the water quality impacts of discharging dredged materials at the sites. The majority of the guidelines were promulgated in the EPA publication, Quality Criteria for Water,[3] and updated in the 28 November 1980 Federal Register,[4] and provide for the protection and propagation of fish and other aquatic life and for recreation in and on the water in accord with the 1983 goals of Public Law (P.L.) 92-500. The criteria were established in large part for evaluating long-term discharges from industrial point sources, not for assessing intermittent releases from dredged material discharge operations and long-term releases from discharged sediments. However, they provide protective guidelines for use in assessing disposal activities. Parameters without specific criterion were assigned guideline values based on available literature and/or State standards.

37. If a parameter was present in greater amounts in the elutriate analyses than in the guidelines and receiving water, dredged material disposal may negatively impact water quality at the DS. To determine the magnitude of the impact, the dilution factor and environmental characteristics of the DS must be considered.

38. The elutriate and bulk sediment chemical data on the DS sediments are compared to that on the navigation channel sediments to determine if there are significant differences in the levels of potential contaminants. Of particular concern in terms of the bulk sediment analyses are those parameters which are readily bioaccumulated. These include toxic organic substances, mercury, and lead. The bulk sediment analyses can also be used to interpret elutriate data since certain parameters may be released at high or low levels during an elutriate test even though they are not present in a sediment at such levels. It should be remembered, however, that bulk sediment data represent the total amounts of the parameters present in the sediment including those bound mineralogically. They are not necessarily a measurement of the amounts which are readily available for chemical reaction and biological uptake. The elutriate and background data help in predicting these later potentials.

39. Physical analyses were performed to determine if sediments met the exclusion criteria set up in Section 227.13(b) of the ocean dumping regulations (P.L. 92-532)[20] and Section 230.4-1(b)(1) of the Section 404 regulations.[1] The Portland District, Corps of Engineers, conservatively defines such sediments as consisting of 80 percent by weight of particles larger than silt and containing less than 6 percent organics or volatile solids. The criteria specify that such dredged materials do not have to undergo an evaluation of chemical-biological interactive effects.

40. Sediment sampling exclusively for physical analysis was performed in the navigation channel of Baker Bay on 21 February 1980. These analyses showed that sediments from CM 0 to 2.04 met the exclusion criteria. After Mount St. Helens erupted, large amounts of sediments were deposited in the Columbia River. Some of these fine-grained materials settled in the Columbia River estuary. Only a few of the samples taken in Baker Bay during July 1980 appeared to contain a surface layer of sediments such as would have settled as a result of the volcano. Such material was less than one quarter inch deep. Since chemical analyses of the Mount St. Helens mudflows indicated that there were no parameters of concern in the sediments,[21] the

small amount which appears to have settled in the Baker Bay navigation channel does not justify retesting the sediments from CM 0 to CM 2.04 for their physical characteristics even though the percentage of the sediments which are composed of fine-grained material may have increased.

41. The grain size of sediments is important in determining physical and chemical impacts of discharge operations. Unconsolidated, fine-grained materials, in comparison to larger grained materials, tend to adsorb more contaminants; suspend more readily thus influencing turbidity levels; form fluid mud layers; and spread further upon discharge. Also, deposits of sediments of grain sizes different from those at the receiving site can result in a greatly altered benthic population which may or may not be more productive than the former.

RESULTS AND DISCUSSION

42. Physical Data. Sediments from the navigation channel were collected on both 21 February and 23 July 1980 and underwent an analysis for physical characteristics (table 2; figures 2, 4, 7, and 9). Sediment from CM 2.04 on 23 July was coarser than that collected from the station on 21 February. This is the opposite of what was expected since it was believed that fine-grained material from the Mount St. Helens mudflow in May 1980 would settle in the mouth of the Columbia River and decrease the sediments' average grain size.

43. The District's grain size guideline (20 percent silt) was exceeded in both the February and July samples from the navigation channel at CM 2.04, 2.89, and 3.07 but not in the sediments collected from CM 0 to 2.04. None of the sediments collected contained excessive volatile solids (>6 percent) except for the 21 February sample from CM 2.89 which contained a level slightly higher than the guidelines (6.94 percent).

44. It is possible that an error occurred in determining the volatile solids level in the 23 July, CM 3.07 sample. The level found was .13 percent but sediments from this area appeared to contain more organic

material than the other two navigation channel samples, and chemical analysis revealed that it contained more organic carbon. Also, the sample collected from this station on 21 February contained 5.53 percent organic material, a level which, though lower than the level found in the CM 2.89 station (7.98 percent), is much higher than that found at CM 3.07 on 23 July (.13 percent).

45. Sediments from offshore of DS1, DS2, and the Sand Island upland disposal site varied from silty sand to sand, with the latter predominating. All samples from the Area D disposal site were sand (figures 2 through 6). Volatile solids levels were below District guidelines in all of these sediments. Sediments from the navigation channel (CM 2.04 to 3.07) were, on the average, of lighter density, greater volatile solids levels, and finer grain size.

46. All sediments sampled appeared lightly compacted and the dredged sediments would be expected to disperse as they are discharged, particularly in the high energy regime at Area D. The navigation channel sediments were comparable in shape to sediments at all of the disposal sites (table 2).

47. Since the Baker Bay disposal sites are in areas subject to rapid tidal flows and wake wash from boats, sediments deposited at them will be subject to erosion. It is expected, however, that the majority of sediment deposited on the upland sites will remain in place as have previous discharges.

48. Since the DS's became vegetated following their previous use, some destruction of riparian habitats and eel grass would occur from future disposal operations. On the other hand, these habitats are a result of previous disposal operations and they are expected to recover following future ones provided water flow is not impeded. Strategic placement of sediments may increase the total area which could be colonized.

49. The current regime at Area D is greater than those at the Baker Bay disposal sites as evidenced by the more uniform and larger grain sizes in the former area. Disposal of the Baker Bay sediments at this site will not cause direct destruction of vegetation since the depths in the area are too

great to support plants. On the other hand, sediments discharged at this site will be in greater contact with the water column during descent and will be subject to redistribution after discharge. Initial physical impacts of disposal operations would be increased turbidity and suspended solids levels. Over the long term, virtually all sediments discharged can be expected to be resuspended as they are moved, potentially resulting in release of contaminants adsorbed on them.

50. None of the disposal sites are composed of sediments identical to those in the navigation channel from CM 2.04 to the boat basin, though the DS sediments in Baker Bay more closely resemble these navigation channel sediments than do the Area D sediments. Disposal operations of the upper channel sediments will not involve discharge of like-on-like. Impacts to benthic organisms will result from both crushing and/or suffocation of resident organisms during disposal operations as well as establishment of a substrate which may support a benthic community which is different from that already present.

51. Sediments from CM's 0 to 2.04 are sandy. Discharge of these at the various DS's involve placing like-on-like. Impacts to benthos from such discharges are generally less because the organisms are already adapted to sandy sediment and can readily recolonize it. Impacts to downstream areas upon migration of sediments is less for the same reason.

52. Generally, wavewashed or high current regime areas contain organisms which are more tolerant to movement of, and different types of sediments. Such areas also tend to contain fewer organisms. These factors suggest that organisms in Area D may be better suited to survive discharges of the dredged material than those at the other sites. Alternately, materials could be discharged in upland areas near Baker Bay and only the runoff from the discharges would impact the organisms in the surrounding aquatic areas. Settlement of runoff materials would be comparatively slow and many of the sensitive benthic organisms could escape. At Area D, material is likely to settle quickly in one location causing severe impacts to benthos in that area. However, many organisms in the fringes of this area should be able to burrow to the surface of the discharged sediments.[9]

53. Water Quality Data. Dissolved oxygen (DO), conductivity, oxidation reduction potential (ORP), temperature, pH, and turbidity were measured at the various proposed disposal sites using a Hydrolab 8000 Water Quality Monitoring System and YSI turbidometer (table 4). The DO concentrations (8.70 to 13.53) and temperatures (9.7 to 17.3) measured at all sites were suitable for the survival of adult salmonids. The ORP (182 to 287) indicated that strongly reducing or oxidizing chemical species were not present. Moderately high ORP's, such as these, are characteristic of water which will readily oxidize and precipitate iron and manganese if the parameters are released upon dredged material disposal operations.[5] The pH (7.91 to 8.34) at all stations fell within the range which was suitable for the survival of both freshwater and marine aquatic life.[3] All turbidity measurements (7 to 20 NTU) indicated very clear water with minimal suspended solids levels.

54. Conductivity and temperature data were used to determine the salinity in the estuary.[14] Since measurements were not taken during both low and high tides the extent of freshwater and saltwater influence at each site could not be determined. The available data indicate that the disposal site receiving water within Baker Bay was brackish during high tide, while Area D was fresh to brackish in the surface water and had a high salt content near the bottom. The depth of the halocline at Area D during high tide on 20 August 1980 was located at 4 to 7 meters.

55. Sediment Chemical Data. The 23 sediment samples collected for elutriate testing underwent analyses for up to 52 parameters (table 3). In addition, subsamples from 6 of these sediment samples underwent bulk sediment chemical analyses for 41 parameters (table 5).

56. The elutriate data on sediments from the proposed dredging area were compared to Corps' guidelines and to disposal site receiving water and sediment data to determine which parameters could be released at levels which might impact water or sediment quality at the receiving sites. Only three parameters, mercury, ammonia, and phosphorus, were present in the navigation channel sediment's eluate at levels above freshwater guidelines and only manganese was released at levels exceeding the saltwater guidelines. These parameters are discussed below.

57. Ammonia and phosphorus were present in the eluate at levels only very slightly above the guidelines. Application of even a minimal mixing zone factor (as discussed in 40 CFR 230.61(b)(2)(ii)) would place the levels below guidelines. For this reason, they are not considered contaminants of concern.

58. Mercury was detected at levels of .1 to .3 ug/l in the navigation channel sediment eluate. This level appears a good deal above the guideline level for freshwater, .0017 ug/l. However, a comparison of the two is not justified because the analytical detection limit for mercury is .1 ug/l. The guideline level was established by the EPA without regard for the technical feasibility of measuring the parameter. Comparison of the levels in the navigation channel eluate and receiving water analyses to those in the DS sediment eluates reveals relatively little difference. Also, the bulk sediment chemistry data for mercury was all well below the guidelines. Given these various factors, mercury is not considered a contaminant of concern in the navigation channel sediments.

59. Manganese was released in excessive levels from the saltwater eluates of the navigation channel sediments. These levels (480 ug/l and 1100 ug/l) were several times the Corps' saltwater guideline (100 ug/l). However, the bulk sediment analyses indicated that the metal was not present in excessive levels in the proposed dredged material.

60. Manganese is well-known to be readily released at high levels during elutriate tests.[13] This attribute is the result of reduction of the insoluble, oxidized manganese to soluble manganese (II) with decreasing pH, ORP, and oxygen such as occur during elutriation of sediment. Such excessive levels are not expected to occur during ocean discharges of sediments since the amounts of dilution water prevent the dissolved oxygen, pH, and ORP from dropping to the same extent. Also, manganese normally takes longer to oxidize and precipitate than iron but when they are present together the manganese adsorbs to iron oxides and co-precipitates.[7] Manganese which is elutriated is expected to be rapidly precipitated. No long-term impacts from release of manganese are expected at the Baker Bay, Area D, or ocean disposal sites.

61. The bulk sediment data revealed that three parameters, arsenic, barium, and phosphorus, were present in the sediments at levels above those found in the disposal site sediments and exceeding the guidelines limits. Of these parameters, only phosphorus was also exceeded in the eluate samples and, as was discussed above, it should not significantly impact receiving water quality. Since the other parameters found at comparatively high levels in the bulk sediment analyses were not released in excessive levels during elutriate testing, they should not impact water quality during dredged material discharge activities. For the same reason, it is unlikely that they will be readily released from discharged sediments over the long term at levels which could impact benthos or other aquatic life. To provide a more detailed assessment of their long-term impact at the discharge site, these parameters are discussed below.

62. Arsenic was present within the proposed dredged material (9 to 10 ug/g) at levels only slightly exceeding guidelines (3 to 8 ug/g). Since the dredged material levels were 2 to 5 times the levels in the disposal site sediments (2 to 4 ug/g) and twice the concentrations which have been reported in the earth's crust (5 ug/g),[6] the level found in the dredged sediments is attributed to anthropogenic contamination.

63. The metal was not released at excessive levels during elutriate testing and is not expected to have a negative impact on water quality at the disposal sites. Also, it is not likely that it will be readily released from interstitial sediments subsequent to discharge.

64. Arsenic can be both directly toxic and can be accumulated by aquatic organisms though it evidently is not progressively concentrated.[3] The levels found were only very slightly above the guidelines and the average for the earth's crust. The toxicity or bioaccumulative capacity should not be significant.

65. Barium is used in a wide range of industrial applications and can be a good indicator of anthropogenic contamination.[3] Only one of the levels found in the navigation channel sediments (400 ug/g) was above criteria (60 ug/g). This level was more than 10 times that found at a second station

in the channel and it may have been an anomalous data point. The excessive level found may or may not be indicative of industrial pollution. Given the paucity of industrial activities in the immediate project area it seems unlikely that such is the source. More likely this and other contaminants in the navigation channel came from the boats which use the channel.

66. There are no fresh or saltwater criteria set by the EPA for barium since it is not considered of concern in terms of water quality impacts.[3] It was tested as an indicator parameter only and is not expected to negatively affect the sediment or water quality at the disposal sites.

67. Phosphate phosphorus was present in the navigation channel sediments in amounts which exceeded guidelines and at nearly twice the levels found in the disposal sites. The latter possessed moderately high amounts of the parameter. It was also released in the navigation channel sediments' eluate at a concentration which slightly exceeded freshwater guidelines.

68. Given these data it is evident that phosphorous is present in the navigation channel sediments at levels above background. The parameter is primarily of concern because it can act as a fertilizer which may cause excessive and obnoxious growths of algae in freshwater. Such impacts are of greatest concern in operations that cause long-term continuous release of the parameter--such as sewage outfalls. When releases are short-term, the algal growths which utilize the parameter cannot become established and the phosphate reacts rapidly forming insoluble precipitates which upon settling are not readily released in oxygenated waters.[7] Thus, disposal operations would cause insignificant, short-term impacts to the water quality at the well-oxygenated disposal sites.

69. The relationship between rooted aquatic plants and phosphates in the sediments is not clear but such plants can obtain at least some of their phosphate requirements from the sediments. It is likely that disposal of the navigation channel sediments at the sites which are located in Baker Bay would slightly increase macrophyte productivity.[8] Likewise, increased benthic productivity could occur. Such impacts are expected to be minimal and positive.

70. Saltwater guidelines for phosphate phosphorus do not exist. Eutrophication from excessive plankton growths are not anticipated in saltwater systems.

CONCLUSIONS

71. Proposed dredged sediments from CM 0 to 2.04 in the Baker Bay navigation channel are composed of sand which contains less than the Portland District guideline of 6.0 percent volatile solids. This material meets the exemption criteria (section 404) for chemical-biological testing[1] and no chemical analyses were performed on it. It also meets the exemption criteria of Section 103 of P.L. 92-532 (Marine Protection, Research and Sanctuaries Act of 1972) and is suitable for disposal at EPA approved interim ocean or beach nourishment sites.

72. Physical impacts upon disposal of this dredged material at Area D, the west side of the Sand Island disposal site, DS2, and below the high-water mark at DS1 are expected to be minimal since the disposal operation would involve placing like material on like and significant growths of aquatic plants would not be impacted. However, discharge on the east side of Sand Island or in the upland portion of DS1 would impact significant numbers of aquatic plants and a marsh, respectively, and should be avoided for that reason. The Sand Island DS should be inspected for waterfowl nesting sites prior to disposal operations there. Such sites should be avoided during the operations.

73. Sediments from CM 2.04 to the Ilwaco Boat Basin contain slightly elevated levels of volatile solids as well as being composed substantially of silt. For these reasons, elutriate and bulk sediment chemical analyses were performed on the sediments to determine if excessive levels of contaminants were present. The analyses indicated that levels of certain contaminants were present in amounts above background levels indicating anthropogenic contamination. However, the types and amounts of these contaminants were not sufficient to be cause for concern during and after open water or upland disposal in the estuary.

74. Immediate physical impacts from discharges of these sediments are expected to be similar to those discussed above for the more sandy materials. The main difference between the sediment's impacts is that the discharge of the silty material would cause greater turbidity and suspended solids levels. Suspension of the silt during and after disposal activities can negatively impact esthetics, permit release of adsorbed contaminants, and coat aquatic vegetation. Additionally, light transmission in the water is decreased causing negative impacts to phytoplankton productivity. These impacts are expected to be short-term and minimal at the DS's in question. Ambient turbidity in the Columbia River estuary and nearby ocean reaches is commonly increased by storm events so organisms in the area should be tolerant to fluxes from disposal operations.

75. Long-term physical impacts to benthos from discharges of the two types of materials may differ since some organisms have greater survivability in differing sediment types. Because of the greater similarity between the sediments at the Baker Bay DS's with those in the upper portion of the navigation channel, one would expect less impact to benthos in these areas than would occur if disposal took place at Area D. However, this conclusion may be erroneous because organisms which are characteristic of high energy regimes such as Area D are often able to withstand changing conditions better than those in relatively low energy regimes. Alternately, the Baker Bay DS's are upland and a significant amount of the material placed at them would remain upland and not impact benthic organisms. Finally, material placed in Area D would eventually migrate, potentially impacting benthos in surrounding areas but no longer affecting the disposal site. Given these various factors, it is not possible to estimate which site would experience the least impact without performing an extensive and expensive benthic sampling program and test dumps. Since the amount of fine-grained material to be dredged is relatively small and contamination is not of concern, the expense involved in such a study is not considered justified. It is expected that the higher nutrient levels in the fine-grained materials may promote slightly greater levels of benthic and macrophyte productivity but may cause less benthic diversity.

76. No significant impacts to fish, or municipal water supplies are expected from discharge operations at any of the proposed disposal sites. There is a potential impact to water circulation and current patterns to the wetland area located in the upland portion of DS1. Also, any snowy plover populations in this area may be impacted. For these reasons, material should not be discharged above the high-water mark at this site. Sediments discharged in DS1 should be deposited in water and below the mean lower low water level. Mounds extruding above such a level should be flattened. This management of the material will prevent serious impacts to snowy plover and 'damming' of the marsh, and may promote spread of the marsh vegetation.

77. Disposal at DS1 or DS2 will result in burial of eel grass; however, the eel grass is very sparsely established in these areas with plants numbering approximately one per square yard or less over much of the area. Loss of these vegetated shallows is not considered significant.

78. No information concerning potential archaeological areas of interest has been found. Since the West Baker Bay channel is neighbored by the Fort Canby Military Reservation, which is a National Historic Site and a recreational camping area, disposal operations should be fully coordinated with the Washington State Historic Preservation Officer to avoid impacting areas of concern.

79. The impacts of discharging sediments within Baker Bay differ in type with those of discharging at Area D. It is very difficult to make a final determination as to which sites would be impacted the least for this reason. Provided the management procedures discussed below are followed, all DS's may be used with expectation of minimal impacts.

RECOMMENDATIONS

80. A Finding of Compliance with the requirements of the "Guidelines for Specification of Disposal Sites for Dredged or Fill Material", as discussed in 40 CFR 230 (Vol. 45, No. 249, 24 December 1980), is made for the dredged material disposal operations listed below given the physical and chemical

data discussed in the preceding report. Also discussed below are the disposal restrictions which must be met pursuant to this Finding of Compliance.

81. Sediments from the Baker Bay west navigation channel from CM 0 to the Ilwaco Boat Basin are suitable for disposal at the following disposal sites in the areas described (see figures 1 and 2).

a. Area D - Latitude 46°14'27"N; Longitude 123°57'00"W; 4,000 by 1,000 feet.

b. Disposal Site 1 - East of Ilwaco Boat Basin; from CM 3.0 to 3.19 opposite west channel. Sediments must be discharged below the high-water mark and in such a manner that they will not extend above the low-low water level.

c. Disposal Site 2 - West of Ilwaco Boat Basin; from CM 3.0 to 3.13 opposite west channel, upland or inwater.

d. West Side of Sand Island - Latitude 46°15'43"N; Longitude 124°01'22"W. Sediments must be discharged on the west side of the island to avoid impacts to submerged and emergent vegetation on the east side. Also, the Area to be used as a disposal site should be inspected for waterfowl nesting sites prior to use. Impacts to such nest sites should be avoided.

82. Sediments from RM's 0 to 2.04 are, in addition, suitable for deposit at beach nourishment sites or the designated interim ocean disposal sites listed below:

a. Area A - 46°13'03"N, 124°06'17"W
46°12'50"N, 124°05'55"W
46°12'13"N, 124°06'43"W
46°12'26"N, 124°07'05"W

b. Area B - 46°14'37"N, 124°10'34"W
46°13'53"N, 124°10'01"W
46°13'43"N, 124°10'26"W
46°14'28"N, 124°10'59"W

c. Area E - 46°15'43"N, 124°05'21"W
46°15'36"N, 124°05'11"W
46°15'11"N, 124°05'53"W
46°15'18"N, 124°06'03"W

d. Area F - 46°12'12"N, 124°09'00"W
46°12'00"N, 124°08'42"W
46°11'48"N, 124°09'00"W
46°12'00"N, 124°09'18"W

83. Sediments from RM 2.04 to the Ilwaco Boat Basin may not be deposited at beach nourishment sites or at the ocean disposal sites listed above, without bioassay and bioaccumulation tests being performed to ascertain potential biological and chemical impacts from the discharges.

84. All disposal operations in Baker Bay must be fully coordinated with the Washington State Historic Preservation Officer. Disposal operations at all sites must be coordinated with U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, Washington Department of Ecology, and any other private or public agency which has expressed interest in such operations.

85. The marshy areas at DS1 and the east side of Sand Island and the eel grass beds off of DS1 and DS2 should be surveyed by wetland specialists to ascertain their quality. An indepth literature search and on-site inspection on the reported snowy plover, gull and other bird populations at DS1 and Sand Island should be performed. Such information can help determine if limiting use of these areas is in fact necessary and when disposal operations may be performed.

BIBLIOGRAPHY

1. U.S. Environmental Protection Agency, "Navigable Waters - Discharge of Dredged or Fill Material," Federal Register, Vol. 40, No. 173 (Friday, September 5, 1975).

2. U.S. Army Engineer District, "Columbia and Lower Willamette River Environmental Statement," Portland District, OR, July 1975.

3. U.S. Environmental Protection Agency, "Quality Criteria for Water," Washington, D.C. 1976.

4. U.S. Environmental Protection Agency, "Quality Criteria Documents; Availability," Federal Register, Vol. 45, No. 231 (Friday, November 28, 1980).

5. Collins, J.F., and S.W. Buol, "Effects of Fluctuations in the Eh-pH Environment on Iron and/or Manganese Equilibria," Soil Science, Vol. 110, No. 2 1970.

6. U.S. Environmental Protection Agency, "Arsenic," Report by Subcommittee on Arsenic, Committee on Med. and Biol. Effects of Environ. Pollut., NRC/NAS, Rpt. No. EPA 600/1-76-036, Washington, D.C., 1976.

7. Wetzel, Robert G., Limnology, W.B. Saunders Co., Philadelphia, Pennsylvania. 1975.

8. Thurston, R.V., R.C. Russo, C.M. Fetterolf, Jr., T.A. Edsall, and Y.M. Barber, Jr., Eds., "A Review of the EPA Red Book: Quality Criteria for Water," Water Quality Section, American Fisheries Society, Bethesda, Maryland. 1979.

9. Maurer, D.L., R.T. Keck, J.C. Tinsman, W.A. Leathem, C.A. Wethe, M. Huntzinger, C. Lord, and T.M. Church, "Vertical Migration of Benthos in Simulated Dredged Material Overburdens," U.S. Army Engineers Waterways Experiment Station, Tech. Rep. D-78-35, Vicksburg, Mississippi. June 1978.

10. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Standard Methods for the Examination of Water and Wastewater, 14th Edition, American Public Health Association, Washington, D.C. 1976.

11. Rinella, Frank A., and Greg Fuhrer, "Native Water, Bottom Material and Elutriate Analyses of Selected Estuaries and Rivers in Western Oregon," U.S. Geological Survey, Open File Report 81 -______ (in review).

12. U.S. Environmental Protection Agency, "Guidelines for Specification of Disposal Sites for Dredged or Fill Material, "Federal Register," Vol. 40, Part 230 (Wednesday, December 24, 1980).

13. Lee, G.F., M.D. Piwoni, J.M. Lopez, G.M. Mariani, J.S. Richardson, D.H. Homer, and F. Saleh, "Research Study for the Development of Dredged Material Disposal Criteria," U.S. Army Engineers Waterways Experiment Station, Con. Rpt. D-75-4, Vicksburg, MS, 1975.

14. Brown, N.L., and B. Allentoft, "Salinity, Conductivity and Temperature Relationships of Seawater Over the Range of 0 to 50 ppt," Final Report, March 1. Prepared for the United States Office of Naval Research, Con. Nonr 4290 (00), MJO No. 2003, The Bissett-Berman Corp., 1966.

15. U.S. Environmental Protection Agency and Fish and Wildlife Service, "An Ecological Characterization of the Pacific Northwest Coastal Region," Volume 4: Characterization Atlas-Watershed Unit Descriptions, Con. Rpt. No. 14-16-0009-77-019, U.S. Fish and Wildlife Service, Slidell, Louisiana, July 1980.

16. Seaman, M.H. (Ed), "Columbia River Estuary. Inventory of Physical, Biological and Cultural Characteristics," Washington State Department of Ecology, Olympia, WA, 1977.

17. Peters, C.F., K.D. Richter, D.A. Manuwal, and S.G. Herman, "Colonial Nesting Sea and Wading Bird Use of Estuarine Islands in the Pacific Northwest," U.S. Army Engineer District Seattle, WA, 1977.

18. McMahon, E., M. Leitschuh, D. Werschkul, C. Schibinski, G. Williamson, S. English, G. Vadnois, E. Gassel, R. Eisendrof, and D. Henry, "A Survey of the Great Blue Heron Rookeries on the Oregon Coast," Oregon Institute of Marine Biology, Charleston, OR, 1974.

19. Richardson Associates, "Master Plan for Columbia River at the Mouth, Oregon and Washington," U.S. Army Corps of Engineers District Portland, OR, 1976.

20. U.S. Environmental Protection Agency, "Ocean Dumping - Final Revisions of Regulations and Criteria," Federal Register, Part VI, Vol. 42, No. 7 (Tuesday, 11 January 1977).

21. U.S. Army Engineer District, "Mount St. Helens Eruption, Impacts on the Toutle, Cowlitz, and Columbia River System," Portland District, OR, December 1980.

CORPS OF ENGINEERS U. S. ARMY

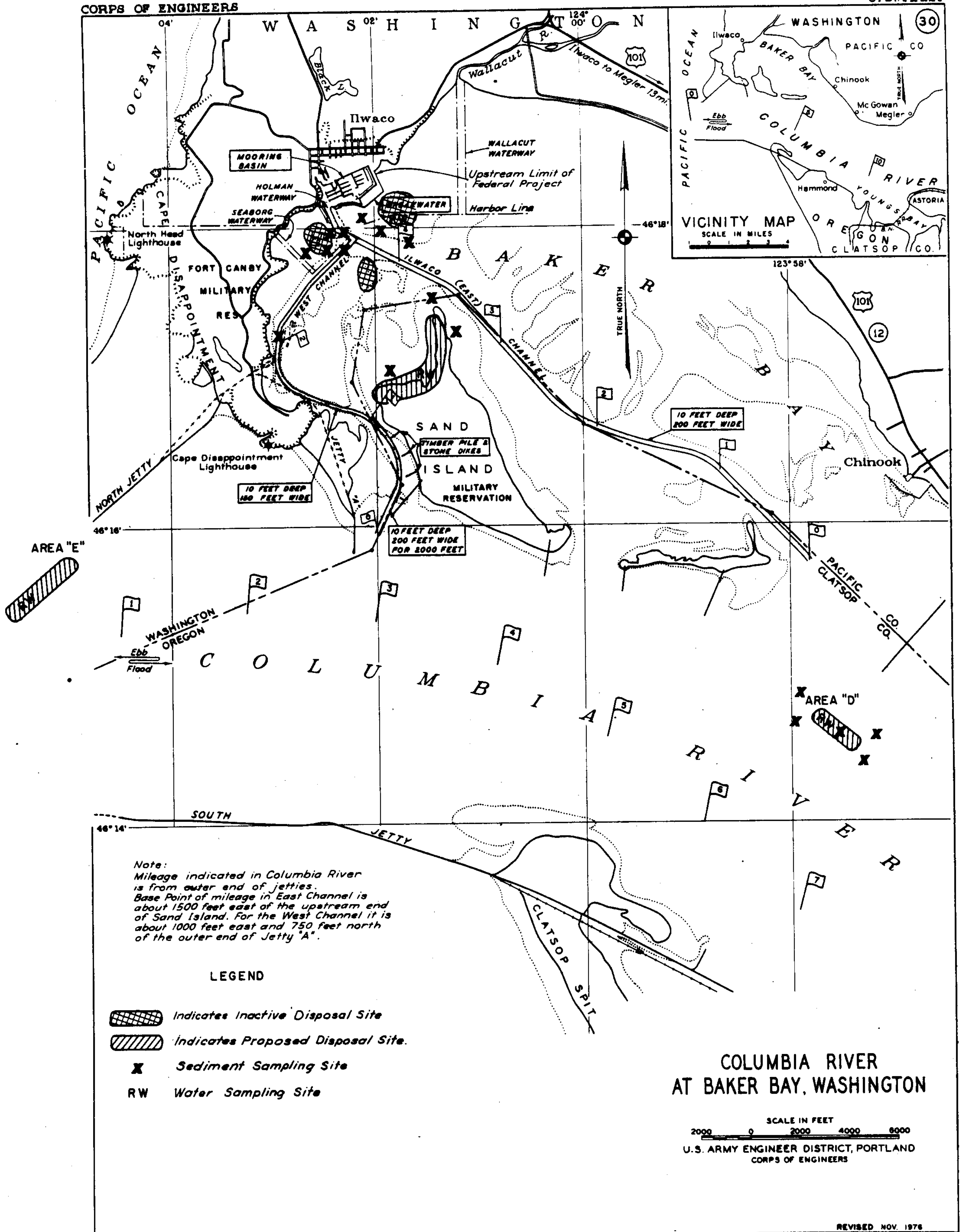
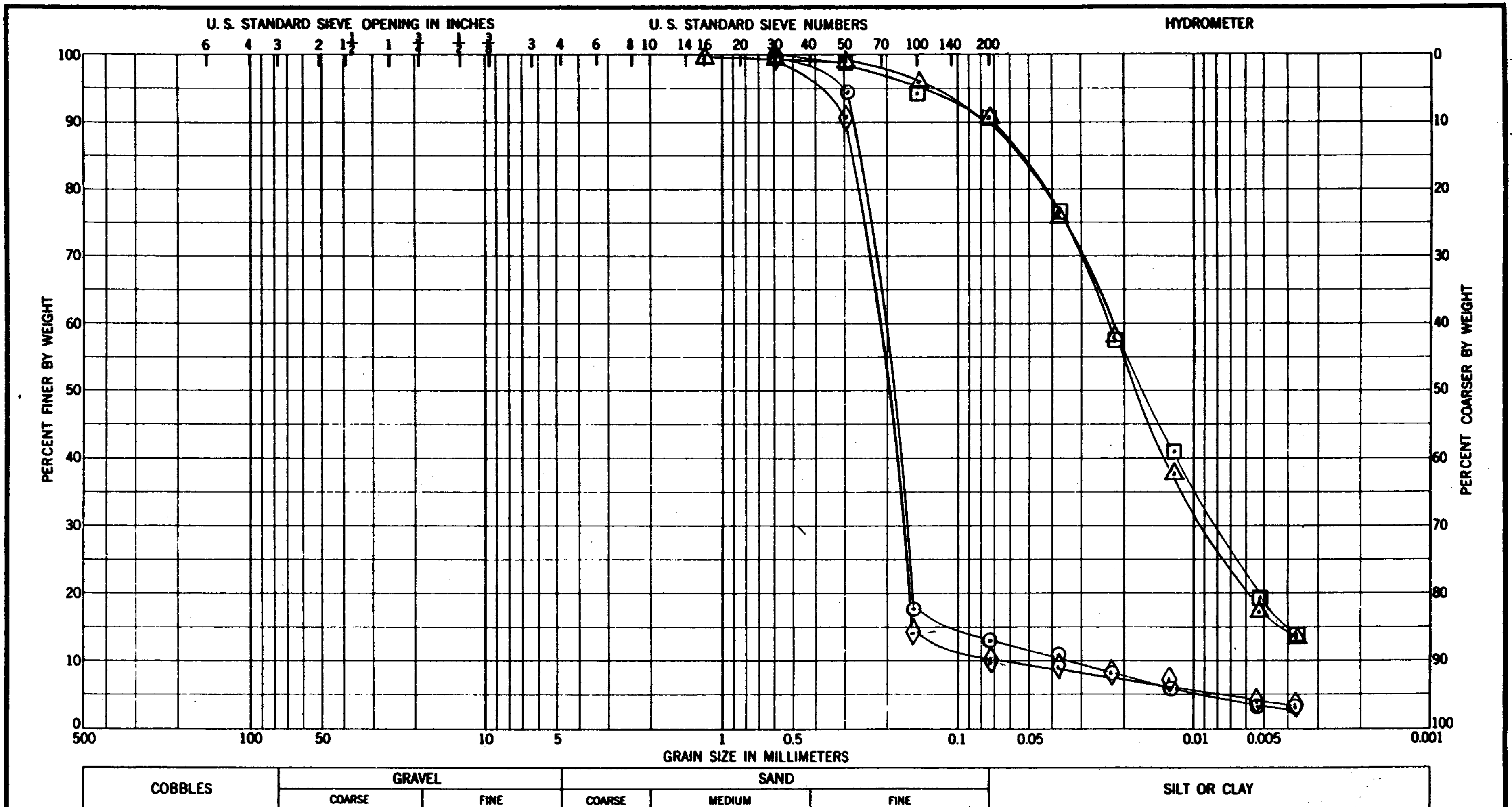


FIGURE I



	Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
⊙	Midchannel	near light 16	Silty SAND (SM)	CM 2.04			
△	N.End Sand	Is. (1100)	Sandy SILT (ML)				
⊡	W.of Buoy 23; South Site (1330)		Sandy SILT (ML)	DS2	CM 3.0		
◇	W.of Buoy 23; Center Site (1500)		Silty SAND (SP-SM)	DS2	CM 3.9		

Project RIVER/COASTAL SEDIMENT ANALYSIS

Baker Bay, Washington

Area

Boring No. sampled: 23 July 1980

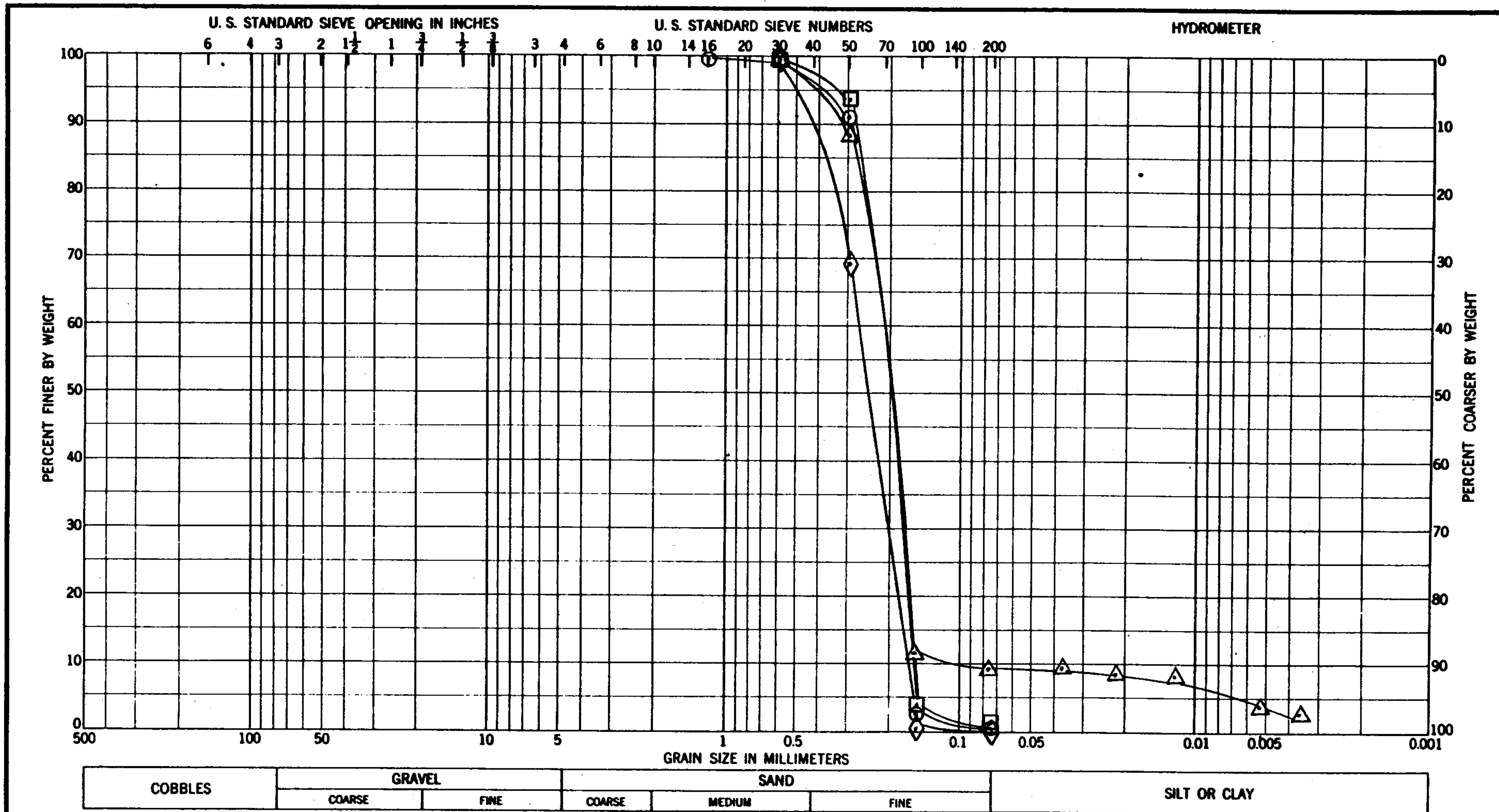
GRADATION CURVES

NPD

Date 22 OCT 1980 (80-S-649)

ENG FORM 1 MAY 63 2087

Figure 2



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
⊙ Center Site; E.of Boat Basin (1415)		SAND (SP)		DS 1	CM3.09	
△ W.of Site No.1; E.of Boat Basin (1415)		Silty SAND (SP-SM)		DS 1	CM 3.19	
⊡ SW Site; E.of Boat Basin (1430)		SAND (SP)		DS1	CM 3.0	
◇ W. of Sand Is. (1045)		SAND (SP)				

Project RIVER/COASTAL SEDIMENT ANALYSIS

Baker Bay, Washington

Area

Boring No. sampled: 23 July 1980

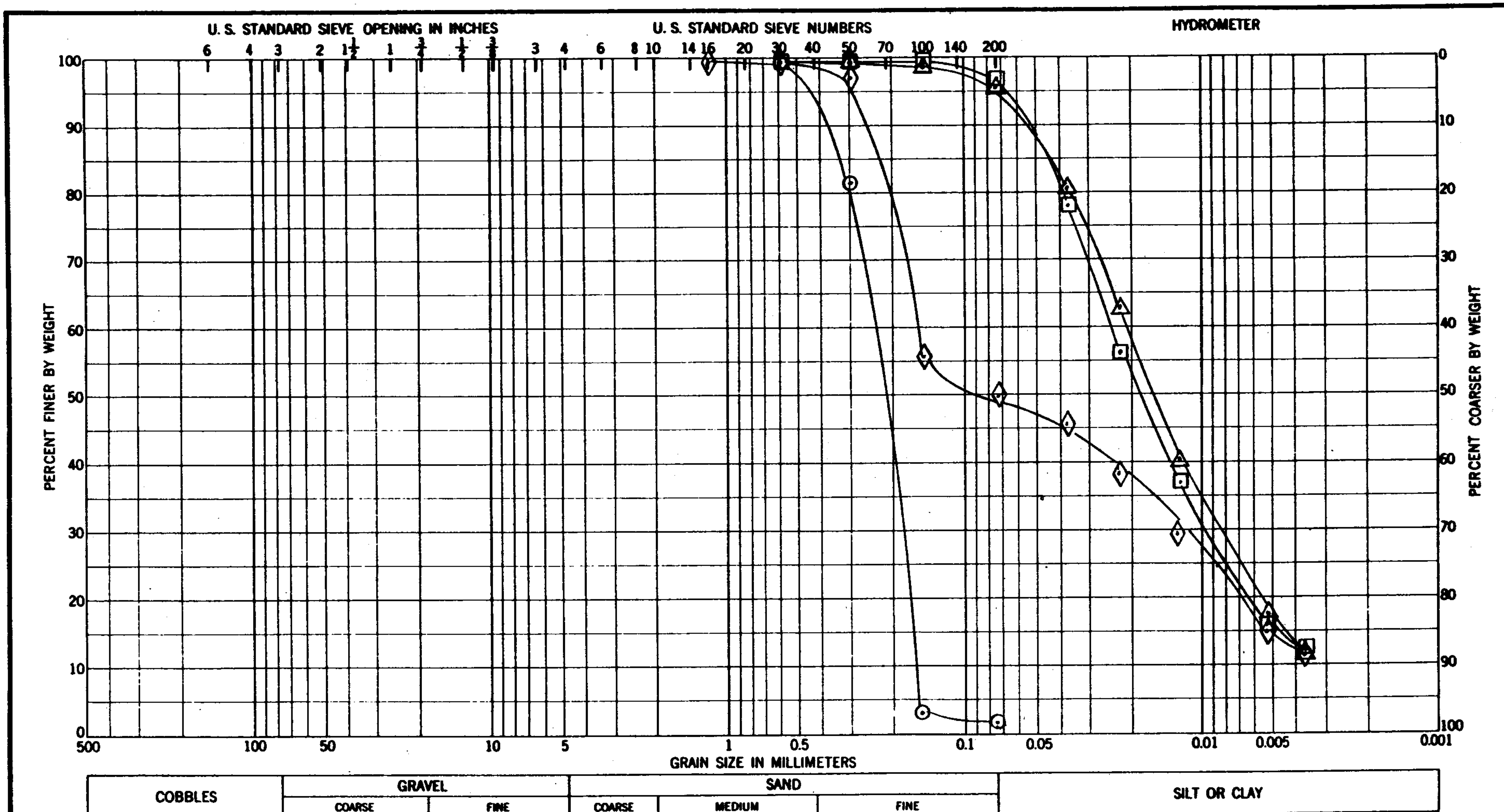
Date 22 OCT 1980 (80-S-649)

GRADATION CURVES

NPD

ENG FORM 1 MAY 63 2087

Figure 3



	Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
⊙	W.of Buoy 23; North Site (1515) 23 July		SAND (SP)	DS2	CM3.13		
△	Buoy 23 (1610) 23 July		SILT (ML)		CM3.07		
⊡	Light 22 (1620) 23 July		SILT (ML)		CM2.89		
◊	Channel Marker 16 (1000) 24 July		Silty SAND (SM)		CM2.04		

Project RIVER/COASTAL SEDIMENT ANALYSIS

Baker Bay, Washington

Area

Boring No. sampled: 23 and 24 July 1980

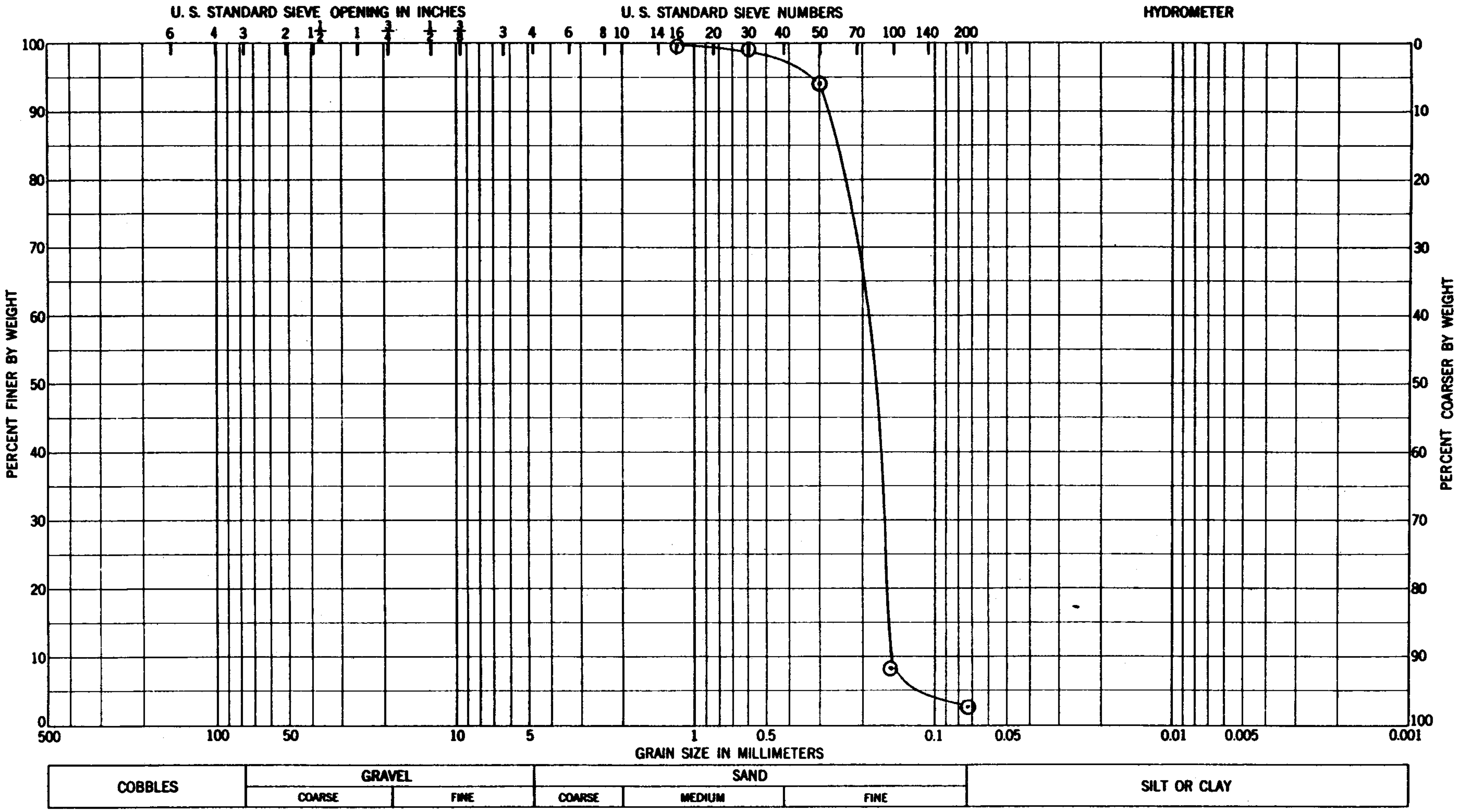
Date 22 OCT 1980 (80-Ch-650)

GRADATION CURVES

NPD

ENG FORM 1 MAY 63 2087

Figure 4



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
⊙ BB-E Sand Island-B		SAND (SP)				

Project RIVER/COASTAL SEDIMENT ANALYSIS

USGS

Area

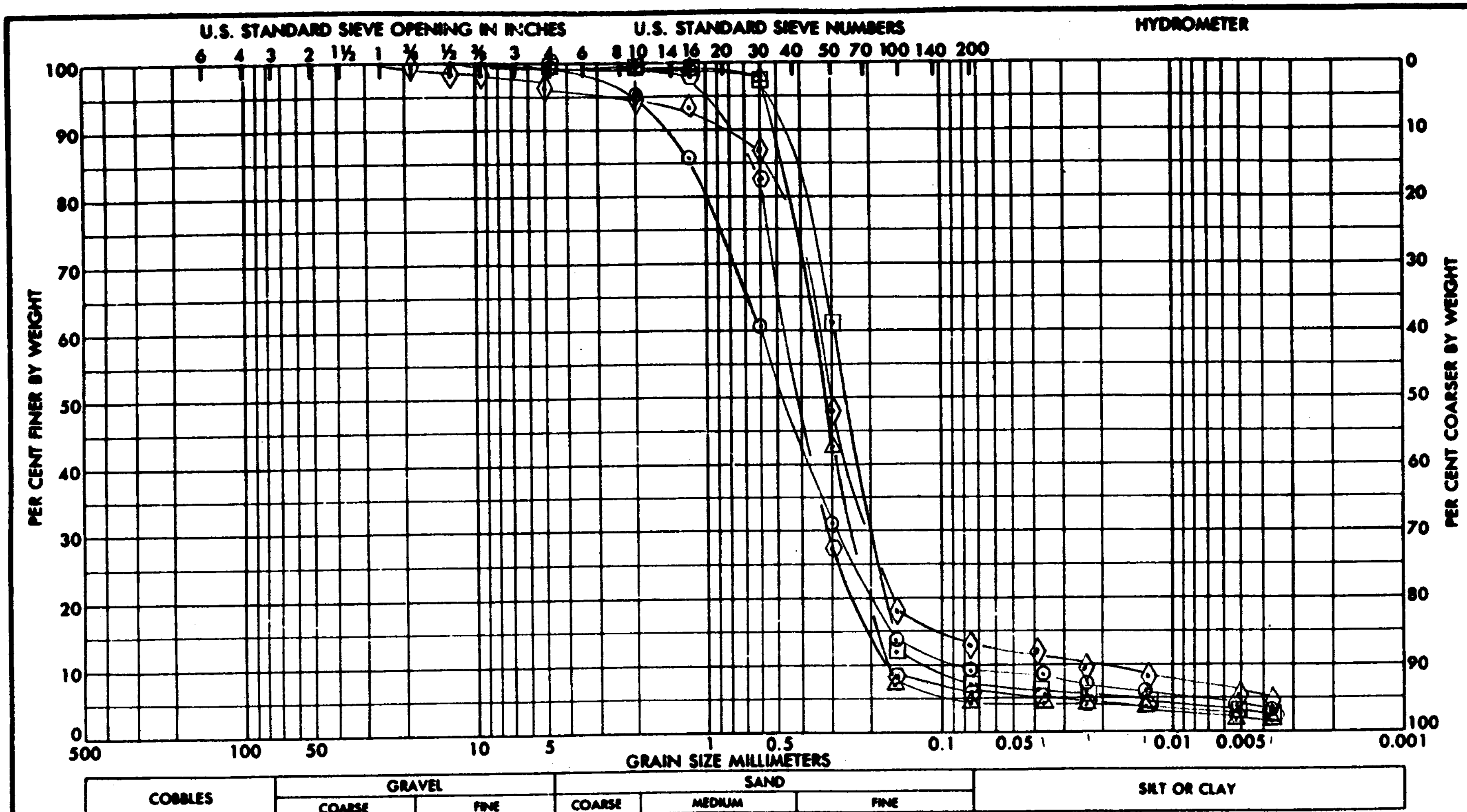
Boring No. Sampled 25 July 1980

Date 22 OCT 1980 (80-Ch-650)

GRADATION CURVES NPD

ENG FORM 1 MAY 63 2087

Figure 5



	SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
⊙	20 Aug 80	Area D-NDS @	68' Si. SAND (SP-SM)				
△	20 Aug 80	Area D-SUS @	35' SAND (SP)				
⊡	20 Aug 80	Area D-NUS @	38' Si. SAND (SP-SM)				
◊	20 Aug 80	Area D-SDS @	60' Si, SAND (SM)				
⊙	20 Aug 80	Area D @	68' Si, SAND (SP-SM)				

GRADATION CURVES NPD

PROJECT RIVER COASTAL SEDIMENT ANALYSIS

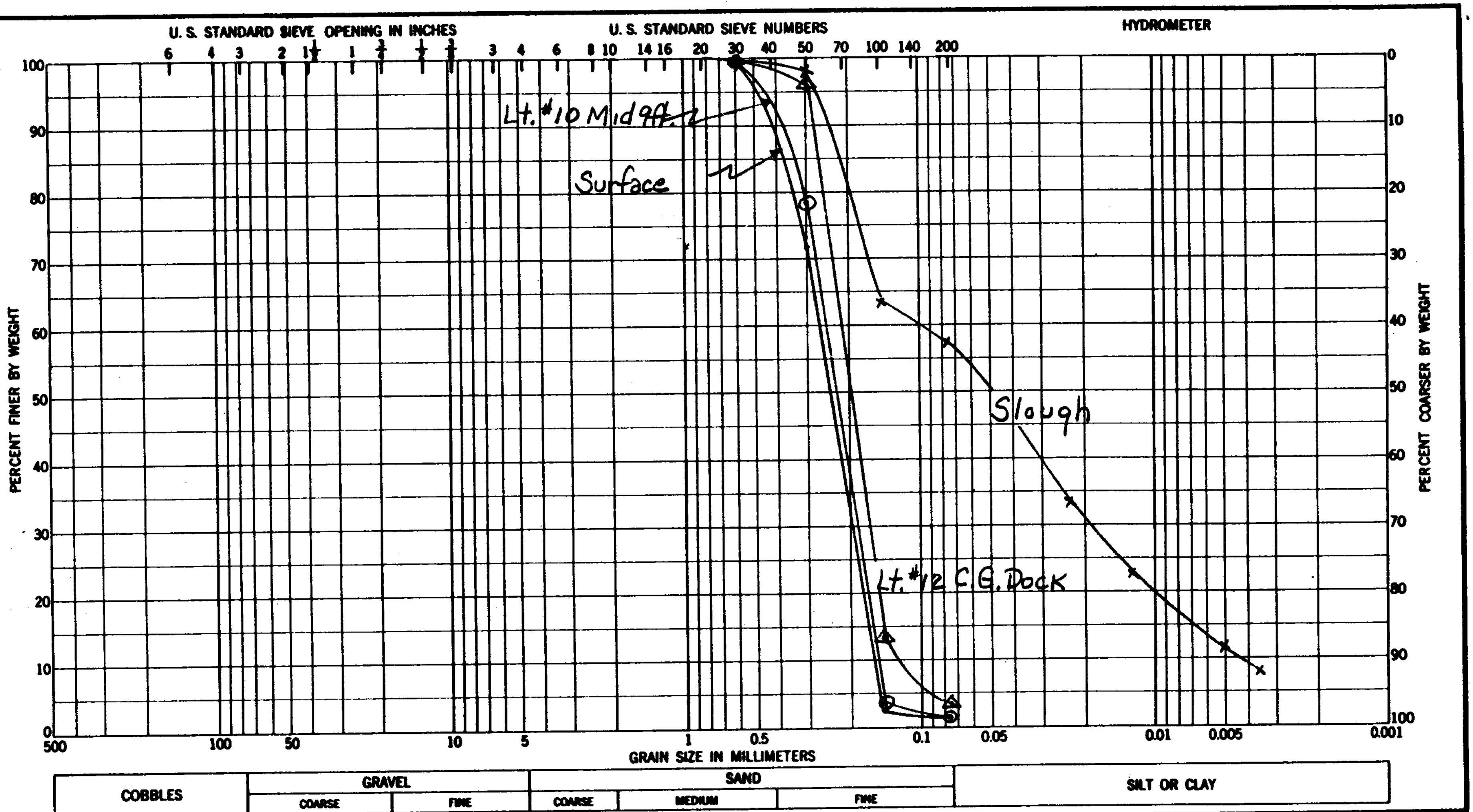
AREA Columbia River

BORING NO.

DATE 28 Jan 81 (81-S-816)

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

Figure 6



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
Surface	Sand Island	SAND (SP)	Beacon Channel			
Slough	Sand Island	Si. SAND (SM)	Beacon Channel			
Lt. #10	Mid. 9 ft	SAND (SP)				
Lt. #12	C.G. Dock	SAND (SP)				

Project: BAKER BAY

Area: Ilwaco, Washington

Boring No.

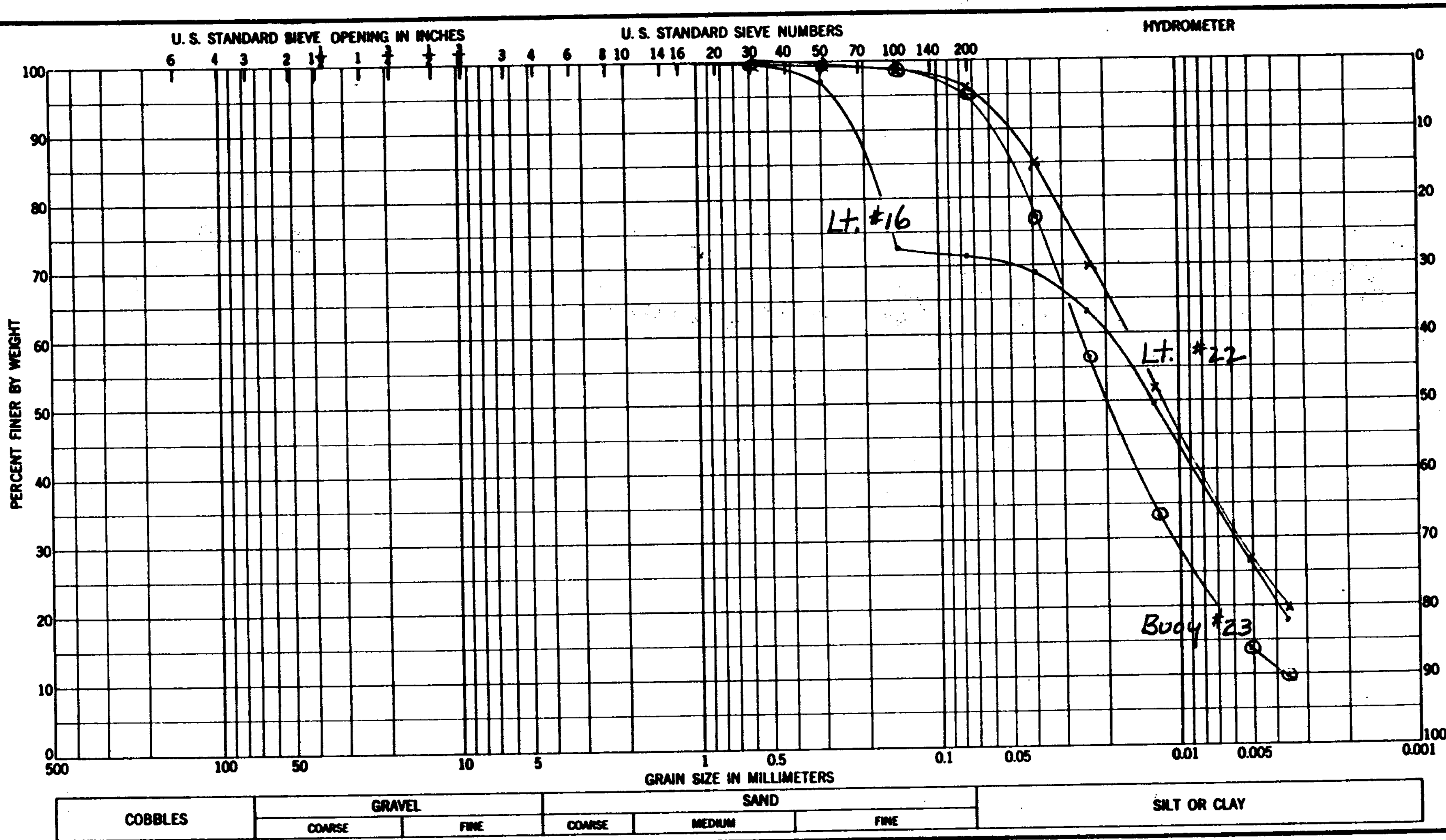
Date: 21 Feb 80 80-SCh-654

GRADATION CURVES

NPD

ENG FORM 1 MAY 63 2087

Figure 7



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
Lt. #16	Mi. 2	Sa. SILT (ML)				
Lt. #22		SILT (ML)				
Buoy #23		SILT (ML)				

Project BAKER BAY

Area Ilwaco, Washington

Boring No.

Date 21 Feb 80 80-SCh-654

GRADATION CURVES NPD

ENG FORM 1 MAY 63 2087

Figure 8

Table 1

Sampling Locations and Methods
Baker Bay, Washington

Sampling location and depth	Sampling Method	Sampling Date	Sampling Time	Type of Sample			
				Benthos	Sediment (Physical)	Sediment (Channel)	Water
Navigation Channel-opposite Buoy 23; 3.07; 18 feet	Gravity Corer	23 Jul 80	1600		X	BF AS	
	Ponar	24 Jul 80		X			
Navigation Channel-opposite Light 22; CM 2.89; 12 feet	Gravity Corer	23 Jul 80	1615		X	BS AF	
	Ponar	24 Jul 80	1035	X			
Navigation Channel-opposite Light 16; CM 2.04; 15 feet	Gravity Corer	23 Jul 80	1615		X	AF AS	
	Ponar	24 Jul 80	1000	X	X		
Ocean Receiving Water-Two miles south of end of south jetty; 6 feet	Van Dorn	24 Jul 80	0900				B
Columbia River Receiving Water-Just offshore of Tongue Point; RM 18.5; 7 feet	Van Dorn	24 Jul 80	1500				B
Baker Bay Receiving Water-East of Sand Island; 1 foot	Van Dorn	25 Jul 80	1400				B
Area D Receiving Water-Area D (46°-14' 27"-N, 123°-57'-00" W) RM 6.6;	Van Dorn	19 Aug 80	1300				B
DS1 Receiving Water-Opposite CM 3.19 (east channel), East of Boat Basin	Van Dorn	25 Jul 80	1400				B
Sand Island NDS-offshore to the north; 5 feet	Gravity Corer	23 Jul 80	1115		X	AF	

Table 1 (cont.)

Sampling location and depth	Sampling Method	Sampling Date	Sampling Time	Type of Sample			
				Benthos	Sediment (Physical)	Sediment (Channel)	Water
Sand Island-WDS-offshore west, 6-8 feet	Gravity Corer	23 Jul 80	1145			AF	
Sand Island-EDS-offshore to the east	Ponar	25 Jul 80	1400		X	Btm AS AF	
DS1-Immediately east of boat basin near shore opposite CM 3.19 (east channel); 2 feet	Hand Corer	23 Jul 80	1340			AF	
DS1-Same as above opposite CM 3.09; .5 feet	Hand Corer	23 Jul 80	1345			Btm AF AS	
DS1-Same as above opposite CM 3.0; 2 feet	Hand Corer	23 Jul 80	1350			AF	
DS2-Immediately west of boat basin near shore opposite CM 3.13 (west channel); 2 feet	Hand Corer	23 Jul 80	1500			AF	
DS2-Same as above opposite CM 3.09; .5 feet	Hand Corer	23 Jul 80	1510			BS BF	
DS2-Same as above opposite CM 3.0, 5 feet	Gravity Corer	23 Jul 80	1320			AF	
Area D-NUS (46°-14'-27" N, 123°-57'-00"W) Upstream of the north corner of disposal site opposite RM 7.0; 38 ft.	Corer	19 Aug 80	1400			BTM BF	
	Ponar	20 Aug 80	0855	X	X		

Table 1 (cont.)

Sampling location and depth	Sampling Method	Sampling Date	Sampling Time	Type of Sample			
				Benthos	Sediment (Physical)	Sediment (Channel)	Water
Area D-SUS-Upstream of south corner of disposal site opposite RM 7.0; 38 feet	Corer	19 Aug 80	1500			AF	
	Ponar	20 Aug 80	0915	X	X		
Area D-Mid-middle of RM 6.6; 68'	Corer	19 Aug 80	1400			AF	
	Ponar	20 Aug 80	0945	X	X		
Area D-NDS-Downstream of north corner of disposal site opposite RM 6.0; 55'	Corer	19 Aug 80	1400			AF	
	Ponar	20 Aug 80	1000	X	X		
Area D-SDS-Downstream of corner of disposal site opposite RM 6.0; 55'	Corer	19 Aug 80	1400			AF	
	Ponar	20 Aug 80	1020	X	X		

A - An "A" analysis includes analyses for approximately eleven metals and nutrients but no complex organic compounds.

B - A "B" analysis includes analyses for approximately 16 metals and nutrients and up to 32 complex organic contaminants.

F - Denotes an elutriate test which was performed using fresh water from Tongue Point.

S - Denotes an elutriate performed with salt water from two miles south of the end of the south jetty.

DS - Dredged material disposal site.

CM - Channel mile.

RM - River mile.

BTM - Bulk sediment chemical analysis.

Table 2

RIVER/COASTAL SEDIMENT ANALYSIS

Baker Bay, Washington

Sample Identification	Specific Gravity of Water	Density of Matl in place gms/liter	Density of Median Solids gms/liter	Void Ratio	% Volatile Solids	% Wtr Content in place	Roundness Grade
Midchannel near light 16 23 Jul 80; CM 2.04	1.0076	1763	2680	1.21	1.82	45.6	Subangular to Subrounded
N. End Sand Is. (1100 23 Jul 80	1.0076	1362	2642	3.62	6.42	137.9	Subangular to Subrounded
W. of Buoy 23; DS2 South Site (1330) 23 Jul 80; CM 3.0	1.0086	1425	2666	2.99	5.19	112.9	Angular to Subangular
W. of Buoy 23; DS2 Center Site (1500) 23 Jul 80; CM 3.09	1.0086	1821	2703	1.09	1.29	40.5	Angular to Subangular
Center Site; DS1 E. of Boat Basin (1415) 23 Jul 80; CM 3.09	*1.000	1920	2.738	0.89	0.81	32.5	Angular to Subangular
West of Site No. 1; DS1 E. of Boat Basin (1415) 23 Jul 80; CM 3.19	1.0086	1773	2678	1.18	1.50	44.6	Subangular to Subrounded
South West Site; DS1 E. of Boat Basin (1430) 23 Jul 80; CM 3.0	1.0086	1893	2691	0.90	0.84	33.8	Subangular to Subrounded
West of Sand Is. (1045) 23 Jul 80	1.0076	1994	2712	0.73	0.48	27.1	Angular to Subangular
East of Sand Is. (1400) 25 Jul 80	1.000	1852	2737	1.04	0.86	37.9	Subangular to Subrounded

Table 2 (cont.)

RIVER/COASTAL SEDIMENT ANALYSIS

Baker Bay, Washington

Sample Identification	Specific Gravity of Water	Density of Matl in place gms/liter	Density of Median Solids gms/liter	Void Ratio	% Volatile Solids	% Wtr Content in place	Roundness Grade
West of Buoy 23; DS2 North Site (1515) 23 Jul 80; CM 3.13	1.0086	1822	2680	1.05	1.20	39.6	Subangular to Subrounded
Buoy 23 (1610) 23 Jul 80; CM 3.07	1.0086	1368	2639	3.54	0.13	135.3	Subangular to Subrounded
Light 22 (1620) 23 Jul 80; CM 2.89	*1.000	1423	2649	2.90	5.53	109.4	Angular to Subangular
Channel Marker 16 (1000) 24 Jul 80; CM 2.04	*1.000	1600	2693	1.82	3.68	67.7	Angular to Subangular
Columbia River N.D.S. Area D @ 68' 20 August 1980	1.011	1920	2703	0.86	0.61		Subangular to@ Subrounded
Columbia River S.V.S. Area D @ 35' 20 August 1980	1.009	1866	2715	0.99	0.91		Subangular to Subrounded
Columbia River N.U.S. Area D @ 38' 20 August 1980	1.009	1934	2722	0.85	0.78		Subangular to Subrounded
Columbia River S.D.S. Area D @ 60' 20 August 1980	1.011	1912	2744	0.92	1.57		Subangular to Subrounded
Columbia River Middle Area D @ 68' 20 August 1980	1.011	1938	2725	0.85	0.70		Subangular to Subrounded

* Distilled water used to saturate sample.

Table 2 (cont.)

RIVER/COASTAL SEDIMENT ANALYSIS

Baker Bay, Washington

Location	Specific Gravity of Wtr	Density of Matl in place gms/liter	Density of Median Solids gms/liter	Void Ratio	% Organic Materials	% Volatile Solids	Roundness Grade
Sand Island west shore 21 Feb 80	1.0031	1931	2723	0.854	0.73	0.56	Subround to Subangular
Sand Island-from small slough 21 Feb 80	1.0028	1407	2633	3.035	5.34	5.14	Subround to Subangular
Lt. #10 Mid. 9 ft. 21 Feb 80	1.0061	1960	2715	0.791	0.57	0.46	Angular to Subangular
Lt. #12, Coast Guard Dock 21 Feb 80	1.0050	2103	2938	0.760	0.61	0.56	Subround to Subangular
Lt. #16, RM 2 21 Feb 80	1.0080	1402	2660	3.196	5.46	5.36	Subround to Subangular
Lt. #22 21 Feb 80	1.0067	1418	2591	2.855	7.98	6.94	Angular to Subangular
Buoy #23 21 Feb 80	1.0070	1448	2645	2.713	5.53		Angular

Table 3
Elutriate and Water Quality Data
West Navigation Channel and Dredged Material Disposal Sites
Baker Bay, Washington

PARAMETERS	SE E. Side Sand Is	FE E. Side Sand Is	FE N. End Sand Is	FE W. Side Sand Is	FE W. Side DS 2 CM 3.0	FE N. Side DS 2 CM 3.13	FE Ctr of DS 2 CM 3.09	SE Ctr of DS 2 CM 3.09	FE S. End DS 1 CM 3.0	FE W. End DS 1 CM 3.19	FE Ctr of DS 1 CM 3.09	SE Ctr of DS 1 CM 3.09	FE/SE Guidelines
Arsenic, ug/l							2	2					440/508
Barium, ug/l							100	400					
Beryllium, ug/l							0	10					130/
Cadmium, ug/l	0	0	0	0	0	0	0	0	0	0	0	0	1.5/59
Carbon, Organic, mg/l	8.8	24	8.6	3.5	13	11	14	7.8	22	12	12	5	
Chromium, ug/l	0	1	0	0	0	0	0	0	0	0	0	0	21/1,260
Copper, ug/l	1	6	1	0	0	0	2	0	3	1	1	0	12/
Cyanide, ug/l							1	2					52/30
Iron, ug/l	160	290	10	10	110	20	30	160	50	30	20	180	1,000/
Lead, ug/l	1	2	0	0	0	5	1	2	1	3	1	2	74/668
Manganese, ug/l	320	70	40	40	150	10	40	630	10	10	10	90	/100
Mercury, ug/l	0	0	0	0	0	.2	.2	.2	0	.2	.2	0	.0017/3.7
Nickel, ug/l							2	7					1.1/.140
Nitrogen, Ammonia mg/l	.46	.05	1.7	.14	9.5	1.7	.72	1.3	1.7	1.2	.90	1.1	
Nitrogen, Organic mg/l							.93	.82					
Ammonia, Unionized mg/l	.02	.001	.05	.004	.27	.05	.02	.05	.05	.03	.03	.04	.02
Phenol, ug/l	18	38	9	48	34	154	34	11	14	103	31	33	10,200/5,800*
Phosphorus, Total ug/l							147	118					100/
Orthophosphate, ug/l	35	22	141	35	72	85	27	32	210	28	47	37	
Zinc, ug/l	40	10	10	20	10	10	10	40	10	10	10	40	180/170
Aldrin, ug/l							.00						3.0/1.3
Ametryne, ug/l							.0	.0					
Atratone, ug/l							.0	.0					
Atrazine, ug/l							.0	.0					
Chlordane, ug/l							.0						2.4/.09
Cyanazine, ug/l							.0	.0					
Cyprazine, ug/l							.0	.0					
DDD, ug/l							.00						
DDE, ug/l							.00						
DDT, ug/l							.00						1.1/.13
Dieldrin, ug/l							.00						2.5/.71
Endosulfan, ug/l							.00						.22/.034
Endrin, ug/l							.00						.18/.037
Hept Epox, ug/l							.00						
Heptachlor, ug/l							.00						.50/.053
Lindane, ug/l							.00						2.0/.004
Methoxychlor, ug/l							.00						.03/.03
Mirex, ug/l							.00						.001/.001
PCB, ug/l							.0						2.0/10.0
PCN, ug/l							.0						
Perthane, ug/l							.00						
Prometone, ug/l							.0	.0					
Prometryne, ug/l							.0	.0					
Propazine, ug/l							.0	.0					
Silvex, ug/l							.00	.00					
Simazine, ug/l							.0	.0					
Simetone, ug/l							.0	.0					
Simetryne, ug/l							.0	.0					
Toxaphene, ug/l							.0						1.6/.07
2,4-D, ug/l							.00	.00					
2,4-DP, ug/l							.00	.00					
2,4,5-T, ug/l							.00	.00					

Table 3
Elutriate and Water Quality Data
West Navigation Channel and Dredged Material Disposal Sites
Baker Bay, Washington

PARAMETERS	Receiving Water DS 1	Receiving** Water Sand Island	Receiving Water Tongue PT	Receiving Water Ocean	Receiving Water Area D	FE/SE Guidelines
Arsenic, ug/l	1	1	1	1	1	440/508
Barium, ug/l	0	0	0	100	0	
Beryllium, ug/l	10	10		10	10	130/
Cadmium, ug/l	0	0	.04	0	1	1.5/59
Carbon, Organic, mg/l	2.5	2.5	3.4	2.7	4	
Chromium, ug/l	0	0	0	0	1	21/1,260
Copper, ug/l	2	4	3	49	2	12/
Cyanide, ug/l	5	.5	5.0	5.0	2	52/30
Iron, ug/l	90	80	20	200	80	1,000/
Lead, ug/l	2	3	2	4	1	74/668
Manganese, ug/l	20	40	10	60	20	/100
Mercury, ug/l	0	.1	0	.1	.2	.0017/3.7
Nickel, ug/l	1	3	4	2	3	1.1/.140
Nitrogen, Ammonia mg/l	.00	.00	.00	.00	.12	
Nitrogen, Organic mg/l	.42	.64	.43	.32	.37	
Ammonia, Unionized mg/l					.002	.02
Phenol, ug/l	8	5	3	9	5	10,200/5,800*
Phosphorus, Total ug/l	55	53	36	58	87	100/
Orthophosphate, ug/l	35	47	37	43	60	
Zinc, ug/l	20	40	2.5	50	20	180/170
Aldrin, ug/l	.00	.00	.00	.00	.00	3.0/1.3
Ametryne, ug/l	.0	.0	.0	.0	.0	
Atratone, ug/l	.0	.0	.0	.0	.0	
Atrazine, ug/l	.0	.0	.0	.0	.0	
Chlordane, ug/l	.0	.0	.0	.0	.0	2.4/.09
Cyanazine, ug/l	.0	.0	.0	.0	.0	
Cyprazine, ug/l	.0	.0	.0	.0	.0	
DDD, ug/l	.00	.00	.00	.00	.00	
DDE, ug/l	.00	.00	.00	.00	.00	
DDT, ug/l	.00	.00	.00	.00	.00	1.1/.13
Dieldrin, ug/l	.00	.00	.00	.00	.00	2.5/.71
Endosulfan, ug/l	.00	.00	.00	.00	.00	.22/.034
Endrin, ug/l	.00	.00	.00	.00	.00	.18/.037
Hept Epox, ug/l	.00	.00	.00	.00	.00	
Heptachlor, ug/l	.00	.00	.00	.00	.00	.50/.053
Lindane, ug/l	.00	.00	.00	.00	.00	2.0/.004
Methoxychlor, ug/l	.00	.00	.00	.00	.00	.03/.03
Mirex, ug/l	.00	.00	.00	.00	.00	.001/.001
PCB, ug/l	.0	.0	.0	.0	.0	2.0/10.0
PCN, ug/l	.0	.0	.0	.0	.0	
Perthane, ug/l	.00	.00	.00	.00	.00	
Prometone, ug/l	.0	.0	.0	.0	.0	
Prometryne, ug/l	.0	.0	.0	.0	.0	
Propazine, ug/l	.0	.0	.0	.0	.0	
Silvex, ug/l				.00	.00	
Simazine, ug/l	.0	.0	.0	.0	.0	
Simetone, ug/l	.0	.0	.0	.0		
Simetryne, ug/l	.0	.0	.0	.0		
Toxaphene, ug/l	.0	.0	.0	.0	.0	1.6/.07
2,4-D, ug/l				.00	.00	
2,4-DP, ug/l				.00	.00	
2,4,5-T, ug/l				.00	.00	

** From East Side of Sand Island Disposal Site

Table 3
Elutriate and Water Quality Data
West Navigation Channel and Dredged Material Disposal Sites
Baker Bay, Washington

PARAMETERS	SE Nav Ch CM 2.89	FE Nav Ch CM 2.89	SE Nav Ch CM 2.04	FE Nav Ch CM 2.04	SE Nav Ch CM 3.07	FE Nav Ch CM 3.07	FE Area D NUS	FE Area D SUS	FE Area D NDS	FE Area D SDS	FE Area D Mid	Rec. Water Area D	FE/SE Guidelines
Arsenic, ug/l	3					3	1					1	440/508
Barium, ug/l	400					100	500					0	
Beryllium, ug/l	10						10					10	130/
Cadmium, ug/l	0	0	0	0	1	0	1	1	1	3	2	1	1.5/59
Carbon, Organic, mg/l	15	23	13	20	20	35	2.3	2.5	3.5	2.8	40	4	
Chromium, ug/l	0	0	0	1	0	0	0	0	0	0	0	1	21/1,260
Copper, ug/l	1	3	0	1	0	4	1	1	1	1	1	2	12/
Cyanide, ug/l							1					2	52/30
Iron, ug/l	150	50	160	30	170	60	50	50	80	70	60	80	1,000/
Lead, ug/l	3	0	2	0	3	3	0	0	1	1	1	1	74/668
Manganese, ug/l	2100	160	480	20	1100	80	30	20	260	1500	170	20	/100
Mercury, ug/l	.1	0	.2	.2	.1	.3	0	0	.1	.2	.1	.2	.0017/3.7
Nickel, ug/l	3					1	11					3	1.1/.140
Nitrogen, Ammonia mg/l	1.9	1.8	1.9	1.8	1.9	1.8	.18	.09	1.5	2.8	2.1	.12	
Nitrogen, Organic mg/l	26					3.6	.32					.37	
Ammonia, Unionized mg/l	.08	.05	.08	.05	.08	.05	.04	.18	.03	.06	.04	.002	.02
Phenol, ug/l	419	382	37	27	278	324	6	7	7	14	42	5	10,200/5,800*
Phosphorus, Total ug/l						115	78					87	100/
Orthophosphate, ug/l		28	50	38		30	62	53	72	34	35	60	
Zinc, ug/l	30	40	40	10	40	40	20	20	70	30	30	20	180/170
Aldrin, ug/l						.00	.00					.00	3.0/1.3
Ametryne, ug/l	.0					.0	.0					.0	
Atratone, ug/l	.0					.0	.0					.0	
Atrazine, ug/l	.0					.0	.0					.0	
Chlordane, ug/l						.0	.0					.0	2.4/.09
Cyanazine, ug/l	.0					.0	.0					.0	
Cyprazine, ug/l	.0					.0	.0					.0	
DDD, ug/l						.00	.00					.00	
DDE, ug/l						.00	.00					.00	
DDT, ug/l						.00	.00					.00	1.1/.13
Dieldrin, ug/l						.00	.00					.00	2.5/.71
Endosulfan, ug/l						.00	.00					.00	.22/.034
Endrin, ug/l						.00	.00					.00	.18/.037
Hept Epox, ug/l						.00	.00					.00	
Heptachlor, ug/l						.00	.00					.00	.50/.053
Lindane, ug/l						.00	.00					.00	2.0/.004
Methoxychlor, ug/l						.00	.00					.00	.03/.03
Mirex, ug/l						.00	.00					.00	.001/.001
PCB, ug/l						.0	.0					.0	2.0/10.0
PCN, ug/l						.0	.0					.0	
Perthane, ug/l						.00	.00					.00	
Prometone, ug/l	.0					.0	.0					.0	
Prometryne, ug/l	.0					.0	.0					.0	
Propazine, ug/l	.0					.0	.0					.0	
Silvex, ug/l	.00					.00	.00					.00	
Simazine, ug/l	.0					.0	.0					.0	
Simetone, ug/l	.0					.0	.0					.0	
Simetryne, ug/l	.0					.0	.0					.0	
Toxaphene, ug/l						.0	.0					.0	1.6/.07
2,4-D, ug/l	.00					.00	.00					.00	
2,4-DP, ug/l	.00					.02	.00					.00	
2,4,5-T, ug/l	.00					.01	.00					.00	

* These criteria for phenolics were established for phenol. However, the phenolics analysis also measures larger compounds which contain phenol.

RW = Receiving Water
FE = Eluate made with freshwater
SE = Eluate made with saltwater
ug/l = micrograms per liter
ug/l = milligrams per liter

Table 4

HYDROLAB WATER QUALITY DATA

Area D Disposal Site
Mouth Columbia River

DATE: 8-20-80

SAMPLING PERSONNEL: Pam Moore, Bob Ellard, Pat Buckles, Phil Livingstone

WEATHER CONDITIONS: Overcast; 60°

COMMENTS: (Wildlife, vessel traffic, sampling gear difficulties, sampling vessel, etc.)
Fort Stevens sampling boat and hydrolab water quality testing system

	STATIONS							
Parameter	SDS	SDS	NDS	NDS	Mid-Area D	Mid-Area D	NUS	NUS
Depth, meters	1.0	13.2	2.4	9.8	2.0	14.8	9.3	1.8
Dissolved Oxygen, mg/l	8.74	11.25	8.99	11.60	9.08	10.38	11.57	9.69
Conductivity, umho/cm	.158	.505	.164	.492	.163	.507	.470	.122
Salinity, ppt	11		11		11			8
ORP	270	281	254	269	255	270	268	250
Temperature °C	16.6	10.4	16.5	10.8	16.8	10.4	11.3	17.0
pH	7.90	7.99	7.99	8.02	7.93	8.02	8.00	7.98
Turbidity, NTU			10		8		10	
Time	1045	1054	1104	1108	1116			
Approximate Halocline, Depth/Cond, meters/umho/cm	4.6/.353			7.2/.477		6.5/.420	5.7/.420	
Maximum Depth, meters	16.9		12.0			19.9	11.8	

SDS = South and downstream of Area D
NDS = North and downstream
NUS = North and upstream

Table 4 (cont.)

HYDROLAB WATER QUALITY DATA

Baker Bay, Washington

DATE: 8-20-80

SAMPLING PERSONNEL: Pam Moore, Bob Ellard, Pat Buckles, Phil Livingstone

WEATHER CONDITIONS: At 0730-Wind-NW (8 knots); 52°F; 30.20- Barometric Pressure; High tide at 10:30 (5.6' high)

COMMENTS: (Wildlife, vessel traffic, sampling gear difficulties, sampling vessel, etc.)
Used Fort Stevens and Hydrolab Water Quality Testing System

Parameter	DS1	North end Sand Is.	DS2	DS2	Station					
Depth, meters	.2	.7	.5	2.6						
Dissolved Oxygen, mg/L	8.94	9.20	8.79	9.24						
Conductivity, umho/cm	.195	.185	.155	.201						
Salinity, ppt	14	14	11	14						
ORP	282	233	218	216						
Temperature, °C	16.3	16.3	16.7	16.3						
pH	7.92	8.07	7.91	7.96						
Turbidity, NTU		7								
Time	0842	1038	1057							
Maximum Depth, meters			3.1							

DS1 = Disposal Site located immediately east of the Ilwaco Boat Basin.
DS2 = Disposal Site located immediately west of the Ilwaco Boat Basin.

Table 4 (cont.)

WATER QUALITY DATA

Ocean off Columbia River

DATE: 8-21-80

SAMPLING PERSONNEL: Pam Moore, Bob Ellard, Pat Buckles, Phil Livingstone

WEATHER CONDITIONS: ______

COMMENTS: (Wildlife, vessel traffic, completion status of training jetty, sampling gear difficulties, sampling vessel, etc.) Used Fort Stevens and Hydrolab water quality testing system

Parameter	AREA E		OCEAN						
Depth, meters	9.6	.2	13.3	.1					
Dissolved Oxygen, mg/l	10.50	8.71	13.53	10.47					
Conductivity, umho/cm	.530	.215	.524	.348					
Salinity, ppt		17							
ORP	287	261	272	261					
Temperature, °C	9.7	15.7	11.4	14.1					
pH	7.86	8.05	8.18	8.34					
Turbidity, NTU	7								
Time	0921	0926		0943					
Maximum Depth, meters	11.8		14.4						
Saltwedge, Depth/Cond	2.1/.421								

Area E is located at the end of the north Columbia River jetty.
Ocean site was located 3/4 mile southwest of end of the south jetty.

Table 5
Bulk Sediment Analyses
Baker Bay Navigation Channel And Proposed Dredged Material Disposal Sites
July-August 1980

	Mid-Channel Buoy 23	Mid-Channel Light 22	DS 2 CM 3.09 (west channel)	DS 1 CM 3.09	Sand Island Disposal Site East Side	Middle Area D	Guidelines
Aldrin, ug/kg	1.5		0.0	0.0	0.0	0.0	10,000
Arsenic, ug/g	10	9	4	2	2	3	3-8
Barium, ug/g	38	400	20	0	0	20	20-60
Beryllium, ug/g	0	1	0	0	0	0	10
Cadmium, ug/g	2	2	1	0	0	2	6
Carbon, Inorganic, g/kg	0.3	0.0	0.3	0.1	4.1	3.3	
Carbon, Organic, g/kg	20	18	6.4	1.1	0.0	0.0	60
Carbon, Total, g/kg	20	18	6.7	1.2	0.9		60
Chlordane, ug/kg	2	2	0	0	0	0	10,000
Chromium, ug/g	24	15	7	5	5	4	25-75
Copper, ug/g	43	37	17	5	5	4	25-50
Cyanide, ug/g	0	0	0	0	0	1	.1
DDD, ug/kg	0.4	0.3	0.6	0.2	0.0	0.1	10,000
DDE, ug/kg	3.5	2.3	0.0	0.1	0.0	0.0	10,000
DDT, ug/kg	0.1	0.1	0.0	0.5	0.0	0.0	10,000
Dieldrin, ug/kg	0.1	0.1	0.0	0.0	0.0	0.0	10,000
Endosulfan, ug/kg	0.0	0.0	0.0	0.0	0.0	0.0	10,000
Emdrin, ug/kg	0.0	0.0	0.0	0.0	0.0	0.0	10,000
Hept Epox, ug/kg	0.0	0.0	0.0	0.0	0.0	0.0	10,000
Heptachlor, ug/kg	0.0	0.2	0.0	0.0	0.0	0.0	10,000
Iron, ug/g	17000	22000	6900	4000	3100	4700	17,000-25,000
Lead, ug/g	40	30	20	10	10	10	40-60
Lindane, ug/kg	0.0	0.0	0.0	0.0	0.0	0.0	
Manganese, ug/g	280	230	130	54	52	150	300-500
Mercury, ug/g	0.28	0.17	0.06	0.01	0.01	0.01	1
Mirex, ug/kg	0.0	0.0	0.0	0.0	0.0	0.0	10,000
Methoxychlor, ug/kg	0.0	0.0	0.0	0.0	0.0	0.0	10,000
Nickel, ug/g	30	10	10	10	10	10	20-50
Nitrogen, NH_4 mg/kg	130	150	4.9	3.0	4.5	2.0	
Nitrogen, NH_4+Org mg/kg	980	1500	190	130	56	73	1000-2000
PCB, ug/kg	30	10	3	0	0	0	10,000
PCN, ug/kg				0	0	0	10,000
Perthane, ug/kg	0.0	0.0	0.0	0.0	0.0	0.0	10,000
Phosphorus, Tot PO_4 mg/kg	1200	990	530	410	520	430	420-650
Silvex, ug/kg	0	0	0	0	0	0	10,000
Toxaphene, ug/kg	0	0	0	0	0	0	10,000
Zinc, ug/g	190	160	52	21	19	22	90-200
2, 4-D, ug/kg	0	0	0	0	0	0	10,000
2, 4-DP, ug/kg	0	0	0	0	0	0	10,000
2, 4, 5-T, ug/kg	0	0	0	0	0	0	10,000