FINDINGS OF COMPLIANCE
DREDGED MATERIAL DISPOSAL OPERATIONS

CHINOOK FEDERAL NAVIGATION PROJECT
July - August 1980

1. Synopsis. Sediment samples were obtained for elutriate, bulk sediment, chemical, benthic, and/or physical analyses from the Chinook navigation channel in Baker Bay, Washington, at channel miles (CM) .42, 1.32, and 1.96 on 20 August 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. An evaluation of the impacts of discharging sediments dredged from the navigation channel at various disposal sites was made.

BACKGROUND

2. Baker Bay is located on the north side of the Columbia River estuary between river miles (RM) 3 and 9. The Chinook Boat Basin is located in east Baker Bay opposite approximately Columbia RM 8 (figure 1). The turning and mooring basin is 10 feet deep, 275 to 500 feet wide and 660 feet long. The access channel is 10 feet deep and 150 feet wide and extends to deep water in the Columbia River, a distance of approximately 1.5 miles. The mooring basin is protected by a 393-foot-long breakwater.

3. The Corps of Engineers maintains the project depths of the access channel. Approximately 20,000 cubic yards of shoaled sediments are removed from the project annually with a pipeline or hopper dredge. An agitation dredge may be used to remove sediments from the access channel in the future. Dredged sediments have been discharged at either upland or inwater sites. In the future, the latter may be at either ocean or estuary sites. The inwater site most often used in the past has been Area D.

4. The majority of the sediments dredged from the Chinook navigation channel have been from the outer end of the navigation channel and were classified as nonpolluted coastal and alluvial sand with a grain-size classification of fine to medium sand. Sediments at the inwater disposal site, Area D, are also generally composed of sand since the rate of flow in the estuary is high [22] and fine materials are removed. Sediments in and near the mooring basin were silty. These latter sediments, in addition to being fine, contain from 2.09 to 7.61 percent organic material. They have been discharged upland and adjacent to the boat basin in the past.

5. Portland District guidelines specify that sediments to be dredged must undergo a biological and chemical analysis to help determine their environmental impact if they are comprised of more than 20 percent particle sizes smaller than sand or more than 6 percent organic material or volatile solids [1, 12, 27]. Sediment samples from the proposed freshwater or estuarine disposal site(s) for the dredged sediments must also be analyzed to assess impacts of disposal of the dredged materials which do not meet the guidelines.

6. Pursuant to the guidelines, samples were collected for chemical analysis on 19-20 August 1980 from Area D and the navigation channel (figure 1). Samples were analyzed for all contaminants which might be present in the dredged sediments, given the point and nonpoint contaminant sources for the area. The ocean disposal sites were not sampled for sediment since the authority (Section 404 of Public Law 92-500) under which the other sampling was done covered fresh and estuarine areas only and since other sampling programs at the ocean disposal sites have shown that the sediments were noncontaminated sands and gravels.[22]

7. 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 waterway. Current research shows that such log handling can adversely affect water quality.[2]

8. 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.

9. 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 them will settle into the proposed dredging and disposal sites, they must be taken into account in estimating impacts from future maintenance activities.

10. The greatest concern in terms of impacts from the Mount St. Helens eruptions is the large amount of fine-grain materials which have entered the Columbia River and its estuary. Such sediments 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 west Baker Bay navigation channel were taken before and after the Mount St. Helens mudflows.[23] The physical data on them were compared to estimate increases in fine-grain materials among surface sediment samples. No significant increases were found. On the other hand, a layer less than .5 inches deep of pumiceous sand and gravel was found off of Tansy Point during July and August 1981.[25]

11. 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]

12. 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. Despite these various problems, water quality in the Columbia River system is very good (table 3).

13. In the immediate area of the Chinook channel, there are few large sources of contamination. Chinook Boat Basin and its boat traffic are probably the major sources. The town of Chinook may also contribute some municipal wastes and by-products from fish processing and canneries.

14. 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.

15. 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.

16. 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.

17. 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.

18. 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.

19. Mudflats, submerged vegetation and wetlands are located in various areas throughout Baker Bay. Upland disposal operations must be evaluated on an individual basis to access impacts to these special aquatic sites.

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

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

22. 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.

23. 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 east of the Ilwaco Boat Basin.[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 are 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

24. 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.

25. Sediment samples collected for chemical analyses underwent both elutriate and bulk sediment chemical analyses (table 1). 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.

26. 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.

27. 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.

28. 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.

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

ANALYTICAL METHODS

30. 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 USGS 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.

31. Physical analyses of sediments were performed by the Corps' laboratory using both standardized and in-house methods (Table 2). A Hydrolab 8000 water quality testing system was used to measure dissolved oxygen (DO), pH, oxidation reduction potential (ORP), conductivity, and temperature at various sites in Baker Bay, Columbia River, and the ocean (table 3). Turbidity was measured with a YSI turbidometer.

SAMPLING LOCATIONS

32. On 20 August 1980, sediments for the elutriate analyses were collected from the navigation channel at CM .42, 1.32, and 1.96 (see table 1 and figure

1). On 19 and 20 August 1980, five sediment samples were obtained from upstream, downstream, and within the Area D disposal site opposite approximately Columbia RM 7.0, 6.0, and 6.6, respectively.

33. Elutriate analyses were performed using estuarine water obtained on 19 August 1980 from the center of Area D. Ocean water obtained from 2 miles south of the end of Columbia River south jetty and freshwater from Columbia River opposite Tongue Point were sampled and analyzed for comparison purposes (see table 1).

EVALUATION PROCEDURE

34. 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 Area D to estimate the water quality impacts of discharging dredged materials at inwater 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 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 or 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.

35. 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 a disposal site. To determine the magnitude of the impact, the dilution factor and environmental characteristics of the disposal site must be considered.

36. The elutriate and bulk sediment chemical data on the disposal site 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. 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 latter potentials.

37. 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.[1,12] 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.

38. 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;[13] 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

39. Physical Data. Sediments from the navigation channel were collected on 20 August 1980 and underwent an analysis for physical characteristics (table 2; figure 2). The District's grain size guideline (20 percent silt) was

exceeded in all navigation channel samples. Also, the sediments collected from CM 1.32 and 1.96 contained excessive volatile solids (>6 percent).

40. All samples from the Area D disposal site were sand (figure 3). Volatile solids levels were below District guidelines in all of these sediments (table 2). Sediments from the navigation channel were of lighter density, greater void ratio, and finer grain size. Pumice and fine grained material visually resembling that deposited by the Mt. St. Helens mudflow were not found in any of the navigation channel sediments.

41. All navigation channel sediments which were sampled appeared lightly compacted, and the dredged sediments would be expected to spread somewhat as they are discharged, particularly in the high energy regime at Area D. The navigation channel sediments were more angular in shape than sediments at Area D.

42. Disposal of the navigation channel sediments at Area D will not cause direct destruction of vegetation since the depths in the area are too great to support plants. 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. Disposal of the 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.

43. Generally, 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 estuarine site which might possess more silty material and lower energy regimes. Material is likely to settle so as to cause severe, short-term impacts to benthos. However, many organisms in this area should be able to burrow to the surface of the discharged sediments.[9]

44. Water Quality Data. Conductivity, DO, ORP, temperature, pH, and turbidity were measured in Area D and the navigation channel using a Hydrolab 8000 Water Quality Monitoring System and YSI turbidometer (table 3). The DO concentrations (8.70 to 13.53 mg/1) and temperatures (9.7 to 17.3°C) 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 (7.86 to 8.34) at all stations fell within the range suitable for the survival of both freshwater and marine aquatic life.[3] All turbidity measurements (7 to 20 NTU) indicated clear water with minimal suspended solids levels.

45. 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 navigation channel 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. The maximum depth at the center of the site was 19.9 meters.

46. Sediment Chemical Data. The sediment samples collected for elutriate testing underwent analyses for up to 51 parameters (table 4). In addition, subsamples from 2 of these sediment samples underwent bulk sediment chemical analyses for 40 parameters (table 5).

47. 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, ammonia, cadmium, and mercury, 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.

48. Ammonia was 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))[12] would place the levels below guidelines. For this reason, it is not considered a contaminant of concern. The impact from release of the chemical would be short-term and insignificant.

49. Cadmium was released in one of the three navigation channel sediments at a concentration (2 ug/l) slightly above freshwater guidelines (1.5 ug/l). Two of the Area D samples (2 and 3 ug/l) equaled or exceeded the navigation channel eluate. All levels detected were below the marine guideline (59 ug/l). Since only one of the samples was above guidelines and the difference was slight, the impact of cadmium release on water quality during disposal operations should be easily negated by dilution. The relatively high levels already found at Area D suggest that additional impacts from discharge operations would be negligible.

50. Manganese was released in the freshwater eluates of the navigation channel sediments at high levels. The levels (1000 to 1300 ug/l) were several times the Corps' saltwater guideline (100 ug/l). However, the bulk sediment analyses indicated that the metal was present in only moderate levels in the proposed dredged material. There are no freshwater guidelines since impacts are not expected in such a system.

51. 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 DO, 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 diluted and precipitated. No long-term impacts from release of manganese are expected at the Area D or ocean disposal sites.

52. Short-term, water quality impacts in the ocean from manganese release would only be likely if disposal operations took place near an area which is a common source of consumable mollusks. The dilution factors at all of the proposed disposal sites should be sufficient to prevent such impacts; however disposal sites proposed in the future must be assessed on an individual basis for impacts to mollusks.

53. Mercury was detected at a level of .1 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 disposal site sediment eluates reveals that the ambient levels at Area D and the ocean were higher than or equal to the data. Also, the bulk sediment chemistry data for mercury was well below the guideline. Given these various factors, mercury is not considered a contaminant of concern in the navigation channel sediments.

54. The bulk sediment data on sediments from CM 1.32 revealed that three parameters, arsenic, cadmium, and phosphorus, were present in the sediments at levels above those found in the disposal site sediments and exceeding the guideline limits. Five additional parameters, barium, copper, manganese, nitrogen, and zinc, were found at levels denoting moderate sediment contamination. Of these parameters, only cadmium, nitrogen (ammonia), and manganese were also excessive in the eluate samples and, as was discussed above, they 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 either. To provide a more detailed assessment of the parameters' long-term impact at the discharge site, they are discussed below.

55. Arsenic was present within the proposed dredged material (10 ug/g) at a level only slightly exceeding guidelines (3 to 8 ug/g). Since the dredged material levels were 3 times the levels in the disposal site sediments (3

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 may be attributed to anthropogenic contamination.

56. 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, studies indicate that the highly toxic, trivalent inorganic arsenic is converted to the less toxic, pentavalent form within 30 days and benthos survival would be normal in lake muds containing as much as 1920 ug/g.[3,24]

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

58. <u>Barium</u> is used in a wide range of industrial applications and can be a good indicator of anthropogenic contamination.[3] The level found in the navigation channel sediments (40 ug/g) was in the moderately contaminated range (20-60 ug/g). The level at Area D was 20 ug/g. 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.

59. 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.

60. <u>Cadmium</u> is acutely toxic to fish at levels as low as 1 ug/l. It is also bioaccumulated to a significant extent and is a persistent contaminant. Mutagenic and carcinogenic properties are associated with it.[26] On the other hand, increased hardness or salinity tend to decrease cadmium toxicity.[3]

61. The bulk sediment level of this parameter was only slightly above guidelines. Since disposal of the sediments would be in brackish or saline environments, the toxicity of the cadmium is not expected to be significant. The bioaccumulative capacity cannot be predicted given the data which is available since cadmium is subject to a number of synergistic and antagonistic reactions.

62. Copper. Sediment from CM 1.32 was moderately contaminated with copper. Copper is commonly used in paint and wood preservatives to prevent fouling and damage caused by marine organisms. It is a micro-nutrient required by most organisms, but is toxic to aquatic life and plants in higher concentrations. Since only trace amounts of copper were released in the freshwater elutriate tests, the copper in sediment is likely to be tightly bound to the substrate and should not cause adverse impacts during disposal activities. This is even more likely to be the case if dredged material is discharged in the estuary or ocean since copper is readily precipitated in the saline environment.[3] Since the level found was only in the moderately contaminated range and the amount of materials to dredged is not great, impacts from the proposed disposal operations are expected to be insignificant.

63. Manganese was present in the navigation channel sediments at a level (420 ug/g) which was more than twice that found at Area D (150 ug/g) and was within the moderately contaminated range (300-500 ug/g). Manganese is rapidly precipitated in oxygenated water and is not of particular concern in terms of benthic organisms.[3] Since the levels found were only moderately high and the quantity of proposed dredged material is small, significant impacts from manganese are not expected to result from disposal operations.

64. Nitrogen is of concern primarily because it acts as a nutrient. As such, it may cause obnoxious growths of algae or aquatic weeds. Neither of these flora are expected to be impacted by the discharge of the sediments at Area D or the ocean. However, upland disposal of sediments with subsequent discharge into an area of low energy regime and mixing could potentially impact the receiving area. Such disposal operations and the potential impacts must be evaluated on an individual basis.

65. Phosphate phosphorus was present in the navigation channel sediments in amounts (970 mg/kg) which exceeded guidelines (650 mg/kg) and were more than twice the levels found at Area D (430 mg/kg). The latter possessed moderately high amounts of the parameter. It was not released in the navigation channel sediments' eluate at concentrations which exceeded guidelines.

66. Given the bulk sediment chemistry 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 and cannot therefore cause long-term impacts unless the area is shallow enough to support rooted vegetation.[7] Thus, disposal operations would cause insignificant, short-term impacts to the water quality at the well-oxygenated disposal sites. Since all inwater sites are deep, no impacts on rooted aquatics are expected at them. Upland sites must be evaluated and managed individually.

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

68. Zinc was present in the navigation channel at a level (135 ug/g) which fell within the moderately contaminated range (90-200 ug/g) and considerably above the Area D level (22 ug/g). Generally the toxicity of zinc is increased as DO and hardness decrease and temperature increases.[3] The estuarine freshwater is soft but the DO and temperature should have a positive effect on zinc toxicity when disposal takes place at Area D. Long-term impacts from zinc in the discharged sediments are not expected to be significant.

CONCLUSIONS

69. Sediments from CM 1.32 to the Chinook Boat Basin contained slightly elevated levels of volatile solids, sediments from CM .42 to the boat basin were composed substantially of silt. For these reasons, elutriate and bulk sediment chemical analyses were performed on the sediments to help determine biological and chemical impacts of discharging the sediments. The analyses indicated that levels of certain contaminants were present in amounts above background levels indicating anthropogenic contamination. The types and amounts of each individual contaminant in the eluates were not sufficient to be cause for concern in terms of water quality impacts during open water disposal operations. However, synergistic or antagonistic, long-term reactions between the various chemicals could not be adequately assessed given the available data. A solid phase bioassay and bioaccumulation study is recommended for assessing long-term impacts from proposed open water disposal operations.

70. Sediments near CM 0 of the channel did not appear as contaminated as those from CM 1.32 to the boat basin. The chemical data on these indicate less potential for impact. For this reason, the sediments from CM 0 to approximately CM 1 may be discharged without further testing at estuarine disposal sites where their silt content is not of concern.

71. Since elutriate analyses indicated minimal impact to water quality, upland disposal of all sediments may be performed without bioassay or bioaccumulation studies. The disposal site would require management and monitoring to assure that significant impacts to the receiving water do not occur. Also, physical impacts from upland disposal must be evaluated on a site by site basis.

72. Physical impacts from discharges of sediments are expected to be twofold. The silty dredged material may cause greater turbidity and suspended solids levels both during discharge and upon resuspension later. Suspension of the silt can negatively impact esthetics, permit release of adsorbed contaminants, and coat aquatic vegetation. Additionally, light transmission in the water is decreased, potentially impacting phytoplankton productivity.

These impacts are expected to be short-term and minimal at Area D. 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.

73. Long-term physical impacts to benthos may occur from discharges of the dredged materials since some organisms have greater survivability in different sediment types. Because the grain sizes in the disposal site sediments differ from those in the navigation channel, one would expect more impact to benthos than would occur if disposal took place in a normally silty area. 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. 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 the benthic 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, the expense involved in such a study is not considered justified.

74. No significant impacts to fish, threatened or endangered species, vegetated shallows, wetlands, or municipal water supplies are expected from discharge operations at any of the proposed disposal sites. No information concerning potential archaeological areas at the project has been found. Since the channel is neighbored by the Fort Canby Military Reservation, 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.

RECOMMENDATIONS

75. A recommendation for 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 [1,12], 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 and testing requirements which must be followed pursuant to this recommendation for a Finding of Compliance.

76. Sediments from RM 0 to the Chinook Boat Basin may not be deposited at beach nourishment sites unless the sediments at the latter sites possess comparable grain size distributions and volatile solids levels. Ocean disposal may not take place without bioassay and bioaccumulation tests being performed to ascertain potential biological and chemical impacts from the discharges.

77. All upland disposal operations in Baker Bay must be fully coordinated with the Washington State Historic Preservation Officer, 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. Such disposal sites must each undergo an evaluation pursuant to Section 404 of P.L. 92-500. Appropriate management and monitoring procedures may be specified on a site by site basis.

78. Sediments dredged from the Chinook navigation channel from CM 0 to CM 1 are suitable for side casting using an agitation dredge and for disposal at the following estuarine disposal site without further testing.

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

79. Sediments from CM 1 to the Chinook Boat Basin contained a number of parameters at levels above those at the Area D disposal site and in either the moderately or heavily contaminated ranges. Water quality impacts from these parameters are expected to be insignificant; however, long-term, synergistic, antagonistic, and/or bioaccumulative effects on benthos are not predictable given the data obtained in this study. An indepth literature search or bioaccumulation tests should be performed on the various parameters to ascertain impacts before estuarine disposal takes place. Upland disposal of the materials does not require bioassay or accumulation testing; however, each proposed upland disposal site must be evaluated for potential impacts to human uses and special aquatic sites prior to disposal operations. Appropriate management and monitoring procedures must be designed to assure that overflow from the facility will not substantively impact receiving water quality.

FINDING OF COMPLIANCE
CHINOOK NAVIGATION CHANNEL

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, PA. 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, MD. 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, MS. 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, LA. 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.

22. U.S. Army Corps of Engineers "Aquatic Disposal Field Investigations, Columbia River Disposal Site, Oregon; Appendix A: Investigation of the Hydraulic Regime and Physical Nature of Bottom Sedimentation." Technical Report D-77-30, Waterways Experiment Station, Vicksburg, MS.

23. U.S. Army Engineer District, "Findings of Compliance or Noncompliance, Operations and Maintenance Dredged Material Disposal Activities, Baker Bay Federal Navigation Channel," Portland District, OR. July-August 1980.

24. Lueschow, L.A., "The Effects of Arsenic Trioxide used in Aquatic Weed Control Operations on Selected Aspects of the Bio-environment," M.S. Thesis, University of Wisconsin, Madison, 1964.

25. U.S. Army Engineer District, "Findings of Compliance, Dredged Material Disposal Operation, Skipanon Federal Navigation Project," Portland District, OR. June 1981.

26. Sittig, Marshall, (Ed), "Priority Toxic Pollutants," Noyes Data Corps., Park Ridge, NJ. 1980.

27. U.S. Army Engineer District, "Supplemental, Interim Procedures for Evaluating and Testing Discharges of Dredged Materials," Portland District, OR. February 1980.

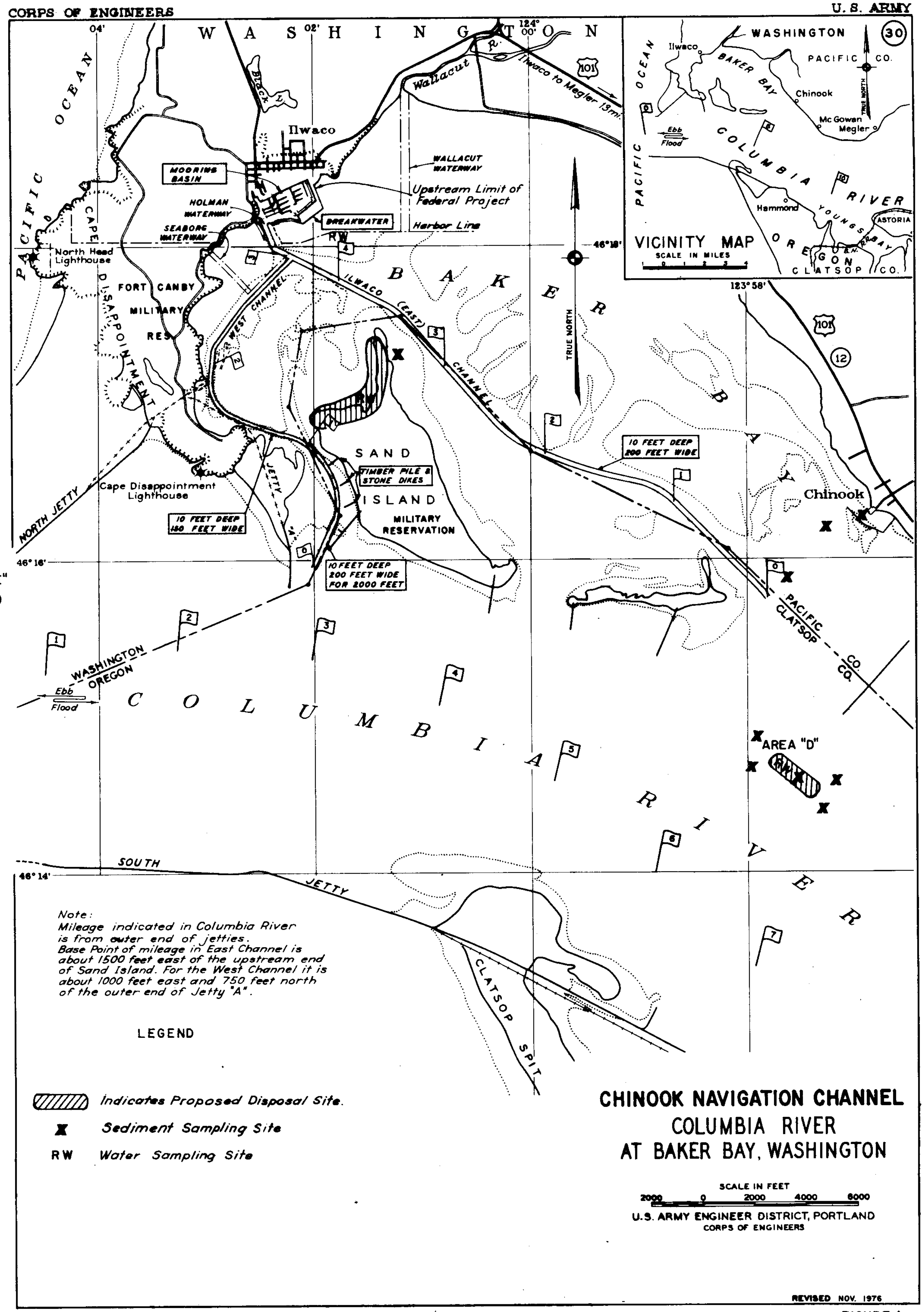
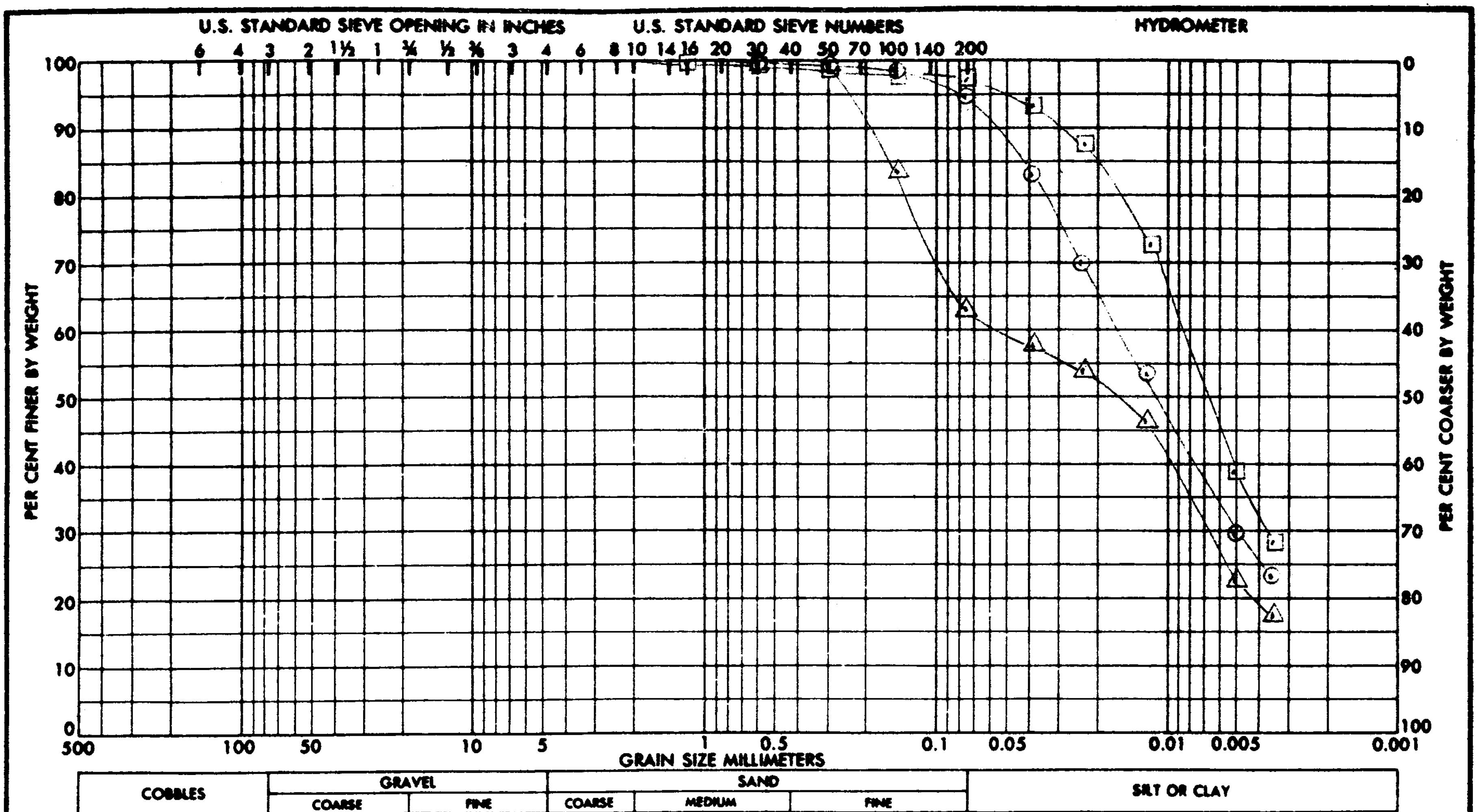

W A S H I N G T O N
PACIFIC OCEAN
Ilwaco
Black L.
Wallacut R.
Ilwaco to Megler 13 mi.
101
MOORING BASIN
HOLMAN WATERWAY
SEABORG WATERWAY
BREAKWATER
RW
WALLACUT WATERWAY
Upstream Limit of Federal Project
Harbor Line
CAPE
North Head Lighthouse
FORT CANBY MILITARY RES
CAPE DISAPPOINTMENT
WEST CHANNEL
ILWACO (EAST) CHANNEL
B A K E R B A Y
TRUE NORTH
46°18'
04'
02'
124° 00'
123°58'
12
SAND ISLAND MILITARY RESERVATION
TIMBER PILE & STONE DIKES
JETTY "A"
10 FEET DEEP 150 FEET WIDE
10 FEET DEEP 200 FEET WIDE
10 FEET DEEP 200 FEET WIDE FOR 2000 FEET
Cape Disappointment Lighthouse
NORTH JETTY
Chinook
46°16'
AREA "E"
RW
WASHINGTON
OREGON
Ebb
Flood
C O L U M B I A R I V E R
PACIFIC CO.
CLATSOP CO.
AREA "D"
RW
SOUTH JETTY
46°14'
CLATSOP SPIT
VICINITY MAP
SCALE IN MILES
WASHINGTON
PACIFIC CO.
Ilwaco
BAKER BAY
Chinook
McGowan
Megler
PACIFIC OCEAN
COLUMBIA RIVER
Hammond
YOUNGS BAY
ASTORIA
OREGON
CLATSOP CO.
30
Note:
Mileage indicated in Columbia River is from outer end of jetties.
Base Point of mileage in East Channel is about 1500 feet east of the upstream end of Sand Island. For the West Channel it is about 1000 feet east and 750 feet north of the outer end of Jetty "A".
LEGEND
Indicates Proposed Disposal Site.
Sediment Sampling Site
RW Water Sampling Site
CHINOOK NAVIGATION CHANNEL
COLUMBIA RIVER
AT BAKER BAY, WASHINGTON
SCALE IN FEET
2000 0 2000 4000 6000
U.S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS
REVISED NOV. 1976

FIGURE 1



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
⊙ Light 5@ 15'	(1400)	CM 1.32 SILT (ML)	20	August	1980	
△ Light 1@ 15'	(1320) CM	.42 Sa. SILT (ML)	20	August	1980	
⊡ Mouth of BB@ 8'	(1415)	CM 1.96 SILT (ML)	20	August	1980	

PROJECT RIVER/COASTAL SEDIMENT ANALYSIS

AREA Chinook Channel

BORING NO.

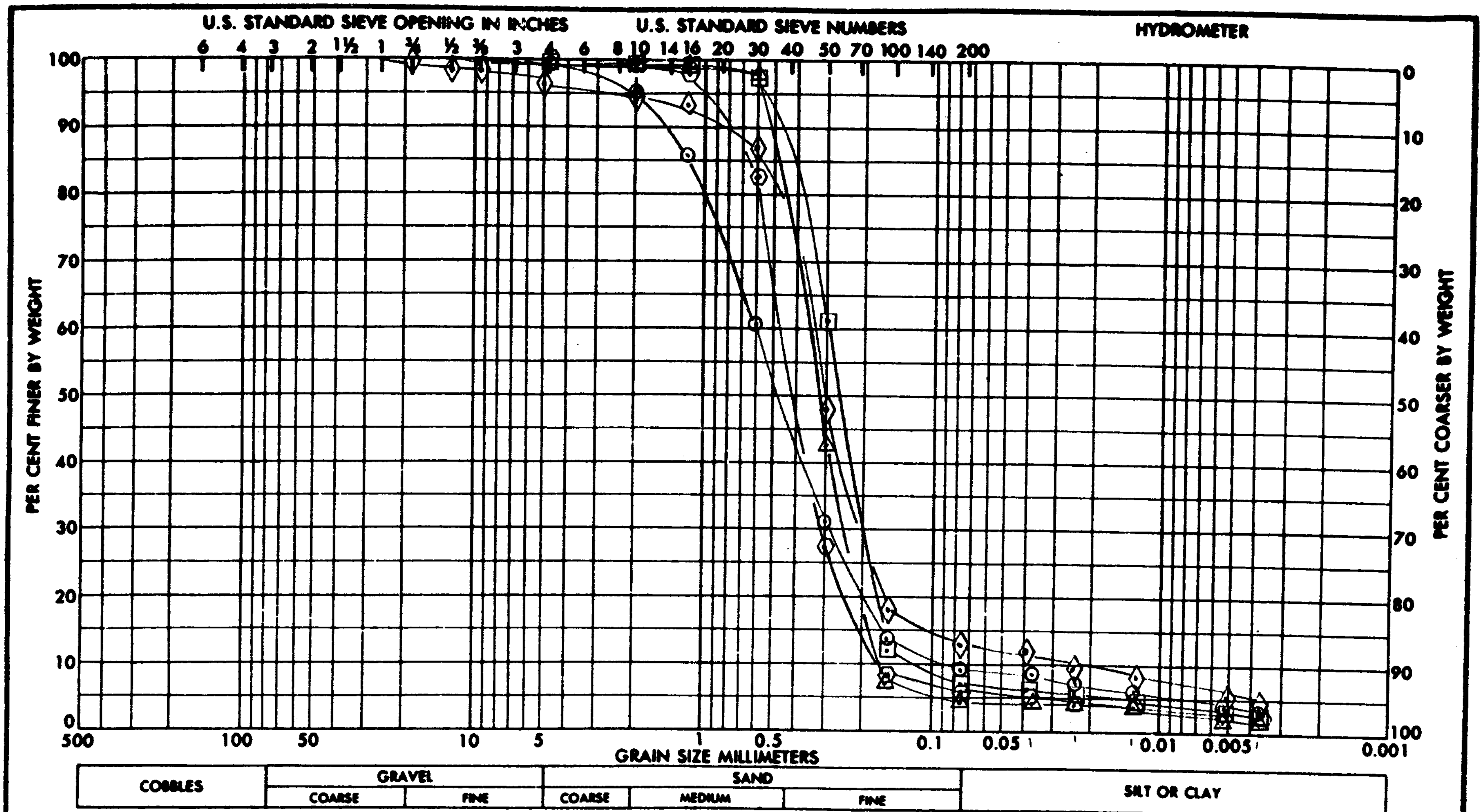
DATE 28 Jan 81 (81-S-816)

GRADATION CURVES NPD

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

U.S. GOVERNMENT PRINTING OFFICE : 1963 O—700-186

Figure 2



	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

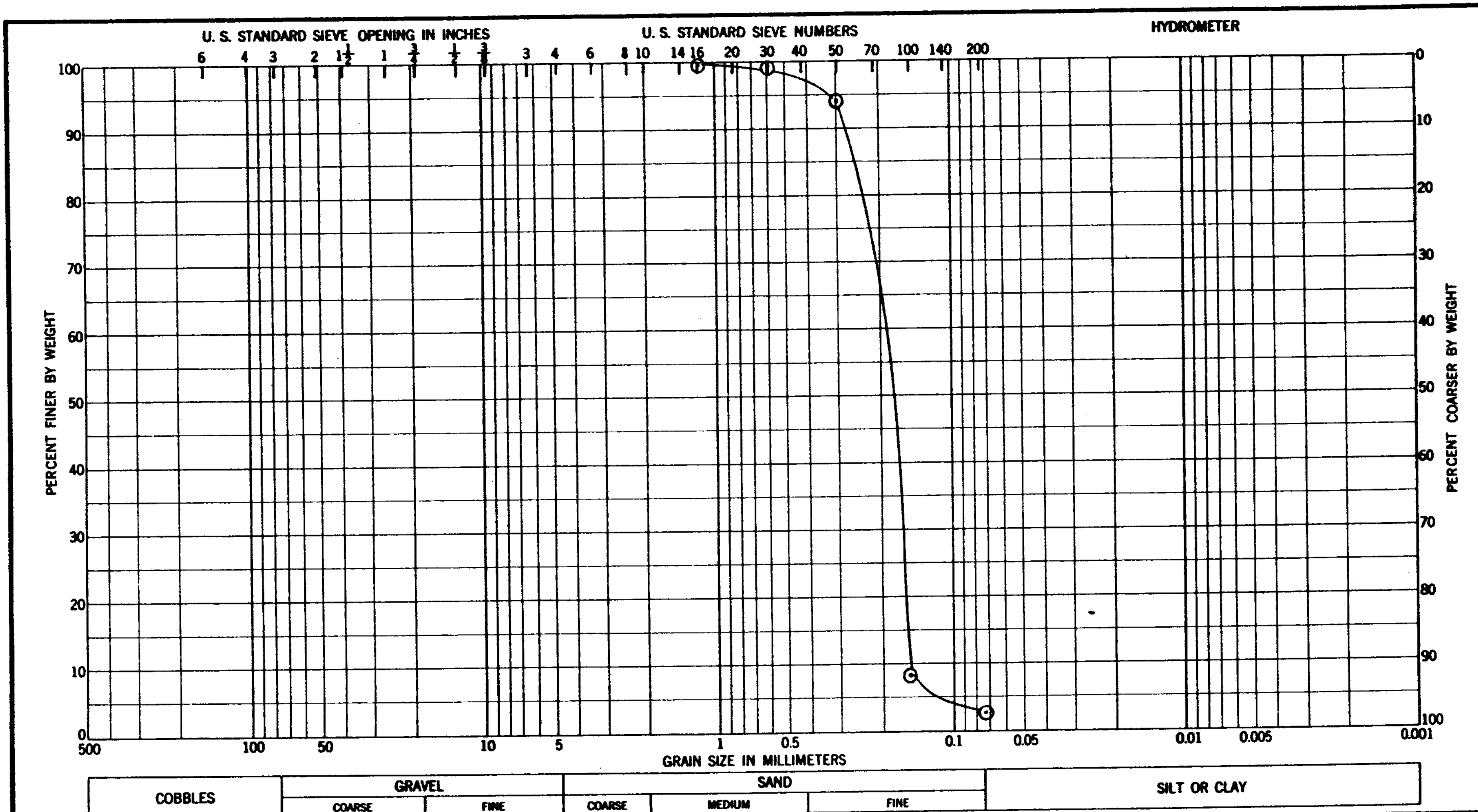
BORING NO.

DATE 28 Jan 81 (81-S-816)

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

U.S. GOVERNMENT PRINTING OFFICE : 1963 OF—700-128

Figure 3



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 4

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 Light 1; CM .42; 15 feet	Gravity Corer	20 Aug 80	1330		X	AF	
	Ponar			X			
Navigation Channel-opposite Light 5; CM 1.32 14 feet	Gravity Corer	20 Aug 80	1355		X	AF BTM	
	Ponar			X			
Navigation Channel-mouth of Boat Basin; CM 1.96; 8 feet	Gravity Corer	20 Aug 80	1415		X	BF	
	Ponar			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

Table 1 (cont.)

Sampling location and depth	Sampling Method	Sampling Date	Sampling Time	Type of Sample			
				Benthos	Sediment (Physical)	Sediment (Channel)	Water
Area D-NUS (46°-14'-27" 123°-57'-00"W) Upstream of the north corner of disposal site opposite RM 7.0; 38 ft.	Corer Ponar	19 Aug 80 20 Aug 80	1400 0855	 X	 X	BTM BF1	
Area D-SUS-Upstream of south corner of disposal site opposite RM 7.0; 38 feet	Corer Ponar	19 Aug 80 20 Aug 80	1500 0915	 X	 X	AF1	
Area D-Mid-middle of RM 6.6; 68'	Corer Ponar	19 Aug 80 20 Aug 80	1400 0945	 X	 X	AF1	
Area D-NDS-Downstream of north corner of disposal site opposite RM 6.0; 55'	Corer Ponar	19 Aug 80 20 Aug 80	1400 1000	 X	 X	AF1	
Area D-SDS-Downstream of corner of disposal site opposite RM 6.0; 55'	Corer Ponar	19 Aug 80 20 Aug 80	1400 1020	 X	 X	AF1	

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

B - A "B" analysis includes analyses for up to 49 parameters including up to 32 complex organic contaminants.

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

F1 - Denotes an elutriate test which was performed using fresh water from Area D.

CM - Channel mile.

RM - River mile.

BTM - Bulk sediment chemical analysis.

Table 2

PHYSICAL SEDIMENT ANALYSIS
CHINOOK NAVIGATION CHANNEL AND
AREA D DISPOSAL SITE

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
Chinook Channel CM 1.32 @ 15' (1400) 20 August 1980	1.0142	1430	2582	2.77	6.18		Angular to Subangular
Chinook Channel CM .42 @ 15' (1320) 20 August 80	*1.000	1583	2649	1.83	2.09		Angular to Subangular
Chinook Channel CM 1.96 of BB @ 8' (1415) 20 August 80	*1.000	1210	2569	6.49	7.61		Angular to Subangular
Columbia River NDS Area D @ 68' 20 August 1980	1.011	1920	2703	0.86	0.61		Subangular to Subrounded
Columbia River SUS Area D @ 35' 20 August 1980	1.009	1866	2715	0.99	0.91		Subangular to Subrounded
Columbia River NUS Area D @ 38' 20 August 1980	1.009	1934	2722	0.85	0.78		Subangular to Subrounded
Columbia River SDS 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
East of Sand Is. (1400) 25 Jul 1980	1.000	1852	2737	1.04	0.86	37.9	Subangular to Subrounded

* Distilled water used to saturate sample.

Table 3

HYDROLAB WATER QUALITY DATA

Baker Bay, Washington

DATE: 8-20-80 - 8-21-80

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); Overcast

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

	Stations						
Parameter	CM 1.96*	CM .42*		AREA E **		OCEAN **	
Depth, meters	.4	.7	4.2	9.6	.2	13.3	.1
Dissolved Oxygen, mg/L	8.70	9.05	10.30	10.50	8.71	13.53	10.47
Conductivity, umho/cm x 10^{-5}	.158	.117	.224	.530	.215	.524	.348
Salinity, ppt	11	8	16		17		
ORP	182	212	216	287	261	272	261
Temperature, C°	16.4	17.3	16.1	9.7	15.7	11.4	14.1
pH	8.03	7.98	7.93	7.86	8.05	8.18	8.34
Turbidity, NTU	13	20		7			
Time			1148	0921	0926		0943
Maximum Depth, meters			5.2	11.8		14.4	
Halocline, Depth/Cond.	3.6/.377			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.

*Tested on 8-20-80

**Tested on 8-21-80

Table 3 (cont.)

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 x 10^{-5}	.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	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
Mid = Middle

Table 4
Elutriate and Water Quality Data
Chinook Navigation Channel and Dredged Material Disposal Sites
Baker Bay, Washington

PARAMETERS	Chinook CM .42	Chinook CM 1.32	Chinook CM 1.96	Water*** Sand Island	Receiving Water Tongue PT	Receiving Water Ocean	Receiving Water Area D	FE/SE Guidelines
Arsenic, ug/l			4	1	1	1	1	440/508
Barium, ug/l				0	0	100	0	
Beryllium, ug/l			0	10		10	10	130/
Cadmium, ug/l	0.18	1	2	0	.04	0	1	1.5/59
Carbon, Organic, mg/l	7.7	18	11	2.5	3.4	2.7	4	
Chromium, ug/l	0	0	0	0	0	0	1	2200/
Copper, ug/l	0	1	8	4	3	49	2	12/
Cyanide, ug/l			3	.5	5.0	5.0	2	52/30
Iron, ug/l	50	130	110	80	20	200	80	1,000/
Lead, ug/l	0	0	1	3	2	4	1	74/668
Manganese, ug/l	1300		1000	40	10	60	20	/100
Mercury, ug/l	0.1	0.1		.1	0	.1	.2	.0017/3.7
Nickel, ug/l			5	3	4	2	3	1100/140
Nitrogen, Ammonia mg/l	8.1		4.5	.00	.00	.00	.12	
Nitrogen, Organic mg/l			33	.64	.43	.32	.37	
Ammonia, Unionized mg/l*	.23		.13				.002	.02
Phenol, ug/l**	7	231	185	5	3	9	5	10,200/5,800*
Phosphorus, Total ug/l			85	53	36	58	87	100/
Orthophosphate, ug/l	37	37	47	47	37	43	60	
Zinc, ug/l	23	20	90	40	2.5	50	20	180/170
Aldrin, ug/l			0.00	.00	.00	.00	.00	3.0/1.3
Ametryne, ug/l			0.0	.0	.0	.0	.0	
Atratone, ug/l			0.0	.0	.0	.0	.0	
Atrazine, ug/l			0.0	.0	.0	.0	.0	
Chlordane, ug/l			0.0	.0	.0	.0	.0	2.4/.09
Cyanazine, ug/l			0.0	.0	.0	.0	.0	
Cyprazine, ug/l			0.0	.0	.0	.0	.0	
DDD, ug/l			0.00	.00	.00	.00	.00	
DDE, ug/l			0.00	.00	.00	.00	.00	1,050/14.0
DDT, ug/l			0.00	.00	.00	.00	.00	1.1/.13
Dieldrin, ug/l			0.00	.00	.00	.00	.00	2.5/.71
Endosulfan, ug/l			0.00	.00	.00	.00	.00	.22/.034
Endrin, ug/l			0.00	.00	.00	.00	.00	.18/.037
Hept Epox, ug/l			0.00	.00	.00	.00	.00	
Heptachlor, ug/l			0.00	.00	.00	.00	.00	.50/.053
Lindane, ug/l			0.00	.00	.00	.00	.00	2.0/.004
Methoxychlor, ug/l			0.00	.00	.00	.00	.00	.03/.03
Mirex, ug/l			0.00	.00	.00	.00	.00	.001/.001
PCB, ug/l			0.0	.0	.0	.0	.0	2.0/10.0
PCN, ug/l			0.0	.0	.0	.0	.0	
Perthane, ug/l			0.00	.00	.00	.00	.00	
Prometone, ug/l			0.0	.0	.0	.0	.0	
Prometryne, ug/l			0.0	.0	.0	.0	.0	
Propazine, ug/l			0.0	.0	.0	.0	.0	
Silvex, ug/l			0.01			.00	.00	
Simazine, ug/l			0.0	.0	.0	.0	.0	
Simetone, ug/l			0.0	.0	.0	.0		
Simetryne, ug/l			0.0	.0	.0	.0		
Toxaphene, ug/l			0.0	.0	.0	.0	.0	1.6/.07
2,4-D, ug/l			0.00			.00	.00	
2,4-DP, ug/l			0.00			.00	.00	
2,4,5-T, ug/l			0.03			.00	.00	

* Extrapolated from table in EPA's "Quality Criteria for Water.[3]
** Measurement of total phenolics including phenol.
*** From East Side of Sand Island Disposal Site

Table 4 (cont.)
Elutriate and Water Quality Data
Area D Dredged Material Disposal Site
Chinook Navigation Channel, Oregon

PARAMETERS	FWE Area D NUS	FWE Area D SUS	FWE Area D NDS	FWE Area D SDS	FWE Area D Mid	RCVG Water Area D	FE/SE Guidelines
Arsenic, ug/l	1					1	440/508
Barium, ug/l	500					0	
Beryllium, ug/l	10					10	130/
Cadmium, ug/l	1	1	1	3	2	1	1.5/59
Carbon, Organic, mg/l	2.3	2.5	3.5	2.8	40	4	
Chromium, ug/l	0	0	0	0	0	1	2200/
Copper, ug/l	1	1	1	1	1	2	12/
Cyanide, ug/l	1					2	52/30
Iron, ug/l	50	50	80	70	60	80	1,000/
Lead, ug/l	0	0	1	1	1	1	74/668
Manganese, ug/l	30	20	260	1500	170	20	/100
Mercury, ug/l	0	0	.1	.2	.1	.2	.0017/3.7
Nickel, ug/l	11					3	1100/140
Nitrogen, Ammonia mg/l	.18	.09	1.5	2.8	2.1	.12	
Nitrogen, Organic mg/l	.32					.37	
Ammonia, Unionized mg/l*	.04	.18	.03	.06	.04	.002	.02
Phenolics, ug/l	6	7	7	14	42	5	10,200/5,800*
Phosphorus, Total ug/l	78					87	100/
Orthophosphate, ug/l	62	53	72	34	35	60	
Zinc, ug/l	20	20	70	30	30	20	180/170
Aldrin, ug/l	.00					.00	3.0/1.3
Ametryne, ug/l	.0					.0	
Atratone, ug/l	.0					.0	
Atrazine, ug/l	.0					.0	
Chlordane, ug/l	.0					.0	2.4/.09
Cyanazine, ug/l	.0					.0	
Cyprazine, ug/l	.0					.0	
DDD, ug/l	.00					.00	
DDE, ug/l	.00					.00	1,050/14.0
DDT, ug/l	.00					.00	1.1/.13
Dieldrin, ug/l	.00					.00	2.5/.71
Endosulfan, ug/l	.00					.00	.22/.034
Endrin, ug/l	.00					.00	.18/.037
Hept Epox, ug/l	.00					.00	
Heptachlor, ug/l	.00					.00	.50/.053
Lindane, ug/l	.00					.00	2.0/.004
Methoxychlor, ug/l	.00					.00	.03/.03
Mirex, ug/l	.00					.00	.001/.001
PCB, ug/l	.0					.0	2.0/10.0
PCN, ug/l	.0					.0	
Perthane, ug/l	.00					.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					.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 5
Bulk Sediment Analyses
Chinook Navigation Channel And Proposed Dredged Material Disposal Site
July-August 1980

	Chinook CM 1.32	Middle Area D	Guidelines
Aldrin, ug/kg	0.0	0.0	10,000
Arsenic, ug/g	10	3	3-8
Barium, ug/g	40	20	20-60
Beryllium, ug/g	0	0	10
Cadmium, ug/g	8	2	6
Carbon, Inorganic, g/kg	1.4	3.3	
Carbon, Organic, g/kg	27	0.0	60
Carbon, Total, g/kg	28		60
Chlordane, ug/kg	4	0	10,000
Chromium, ug/g	18	4	25-75
Copper, ug/g	44	4	25-50
Cyanide, ug/g	0	1	.25
DDD, ug/kg	5.9	0.1	10,000
DDE, ug/kg	5.6	0.0	10,000
DDT, ug/kg	0.0	0.0	10,000
Dieldrin, ug/kg	0.4	0.0	10,000
Endosulfan, ug/kg	0.0	0.0	10,000
Endrin, ug/kg	0.0	0.0	10,000
Hept Epox, ug/kg	0.0	0.0	10,000
Heptachlor, ug/kg	0.0	0.0	10,000
Iron, ug/g	17000	4700	17,000-25,000
Lead, ug/g	30	10	40-60
Lindane, ug/kg	0.4	0.0	
Manganese, ug/g	420	150	300-500
Mercury, ug/g	0.07	0.01	1
Mirex, ug/kg	0.0	0.0	10,000
Methoxychlor, ug/kg	0.0	0.0	10,000
Nickel, ug/g	20	10	20-50
Nitrogen, NH_4 mg/kg	150	2.0	75-200
Nitrogen, NH_4+Org mg/kg	2000	73	1000-2000
PCB, ug/kg	15	0	10,000
PCN, ug/kg		0	10,000
Perthane, ug/kg	0.0	0.0	10,000
Phosphorus, Tot PO_4 mg/kg	970	430	420-650
Silvex, ug/kg	0	0	10,000
Toxaphene, ug/kg	0	0	10,000
Zinc, ug/g	135	22	90-200
2, 4-D, ug/kg	0	0	10,000
2, 4-DP, ug/kg	0	0	10,000
2, 4, 5-T, ug/kg	0	0	10,000