

Chemical analyses of elutriates, native water, and bottom material from the Chetco, Rogue, and Columbia Rivers in Western Oregon

By Gregory J. Fuhrer

U.S. Geological Survey
Open-File Report 84-133

Prepared in cooperation with the
U.S. Army Corps of Engineers



Portland, Oregon
1984

UNITED STATES DEPARTMENT OF THE INTERIOR
WILLIAM P. CLARK, SECRETARY
GEOLOGICAL SURVEY
Dallas L. Peck, Director

For additional information
write to:

U.S. Geological Survey
847 N.E. 19th Ave., Suite 300
Portland, Oregon 97232

Copies of this report can
be purchased from:

Open-File Services Section
Western Distribution Branch
Box 25425, Federal Center
Denver, Colorado 80225
(Telephone: (303) 776-7476)

CONTENTS

| | Page |
|--|------|
| Abstract----- | 1 |
| Introduction----- | 2 |
| Approach and methodology----- | 4 |
| Field procedures----- | 6 |
| Laboratory procedures----- | 8 |
| Monitoring elutriate-test conditions----- | 12 |
| Temperature----- | 12 |
| pH----- | 12 |
| Dissolved oxygen----- | 12 |
| Statistical comparison of 1980 and 1982 reconnaissance data----- | 13 |
| Trace metal release from Columbia River bottom material to elutriation-test mixing water----- | 13 |
| Summary of results----- | 18 |
| Selected references----- | 19 |
| Data tables----- | 23 |

ILLUSTRATIONS

| | Page |
|---|------|
| Figure 1. Map showing locations of the 3 Oregon project areas----- | 3 |
| 2. Graph showing salinity and conductance ranges for marine/estuarine, euryhaline, and fresh classifications----- | 7 |
| 3-5. Figure showing Chetco River: | |
| 3. Map of sampling sites----- | 20 |
| 4. Graph of dissolved oxygen versus time for monitoring the elutriation-test quiescent period----- | 21 |
| 5. Graph showing particle-size distribution----- | 22 |
| 6-8. Figure showing Rogue River: | |
| 6. Map of sampling sites----- | 33 |
| 7. Graph of dissolved oxygen versus time for monitoring the elutriation-test quiescent period----- | 34 |
| 8. Graph showing particle-size distribution----- | 35 |
| 9-11. Figure showing Columbia River: | |
| 9. Map of sampling sites----- | 47 |
| 10. Graph of dissolved oxygen versus time for monitoring the elutriation-test quiescent period----- | 48 |
| 11. Graph showing particle-size distribution----- | 49 |

TABLES

| | |
|--|----|
| | vi |
| Table 1. Conversion factors----- | 5 |
| 2. Detection limits of chemical analyses----- | 10 |
| 3. Recovery of surrogate standards added to bottom-material extracts prior to extraction and gas chromatography/mass spectography analysis----- | 14 |
| 3. Statistical summary of elutriate and bottom-material data from 1980 reconnaissance study versus 1982 reconnaissance study----- | 23 |
| 4a-4i. Chetco River project: | |
| 4a. Location of sampling sites----- | 24 |
| 4b. Dissolved chemicals in native water and elutriates----- | 25 |
| 4c. Additional dissolved chemicals in native water and elutriates----- | 26 |
| 4d. Dissolved organochlorine and chlorophenoxy compounds in native water and elutriates---- | 27 |
| 4e. Results of gas chromatography/mass spectrometry for acid/neutral extractable dissolved organics detected in native water and elutriates----- | 28 |
| 4f. Total recoverable chemicals in bottom material----- | |

TABLES--Continued

| | Page |
|---|------|
| 4g. Total recoverable chlorophenoxy compounds in bottom material----- | 29 |
| 4h. Results of gas chromatography/mass spectrography for acid/neutral extractable organic constituents detected in bottom material----- | 31 |
| 4i. Particle-size distribution of bottom material----- | 32 |
| 5a-5i. Rogue River project: | |
| 5a. Location of sampling sites----- | 36 |
| 5b. Dissolved chemicals in native water and elutriates----- | 37 |
| 5c. Additional dissolved chemicals in native water and elutriates----- | 38 |
| 5d. Dissolved organochlorine and chlorophenoxy compounds in native water and elutriates---- | 39 |
| 5e. Results of gas chromatography/mass spectrography for acid/neutral extractable dissolved organics detected in native water and elutriates----- | 41 |
| 5f. Total recoverable chemicals in bottom material----- | 42 |
| 5g. Total recoverable chlorophenoxy compounds in botttom material----- | 43 |
| 5h. Results of gas chromatography/mass spectrography for acid/neutral extractable organic constituents detected in bottom material----- | 45 |
| 5i. Particle-size distribution of bottom material----- | 46 |
| 6a-6h. Columbia River, Oregon project: | |
| 6a. Location of sampling sites----- | 50 |
| 6b. Dissolved chemicals in native water and elutriates----- | 51 |
| 6c. Additional dissolved chemicals in native water and elutriates----- | 52 |
| 6d. Results of gas chromatography/mass spectrography for acid/neutral extractable dissolved organics detected in native water and elutriates----- | 53 |
| 6e. Total recoverable chemicals in bottom material----- | 54 |
| 6f. Results of gas chromatography/mass spectrography for acid/neutral extractable organic constituents detected in bottom material----- | 55 |
| 6g. Particle-size distribution and percent moisture of bottom material----- | 56 |
| 6h. Release of metals associated with bottom material during elutriation-test mixing---- | 57 |

CONVERSION FACTORS

The following factors may be used to convert English units
to the International System of Units (SI)

| To convert from | to | Multiply by |
|------------------------|---------------------|-------------|
| inch (in.) | millimeter (mm) | 25.40 |
| quart (qt) | liter (L) | 0.9463 |
| gallon (gal) | liter (L) | 3.785 |
| pound (lb) | kilogram (kg) | 0.4536 |
| degree Fahrenheit (°F) | degree Celsius (°C) | <u>1/</u> |

$$\underline{1/} \text{ Temp } ^\circ\text{C} = (\text{temp } ^\circ\text{F} - 32)/1.8$$

ABSTRACT

The U.S. Geological Survey in cooperation with the U.S. Army Corps of Engineers participated in an elutriation study in April and August of 1982. The purpose of the study was to collect reconnaissance data on elutriates, native water, and bottom material which could be used to evaluate short-term impacts of dredging and disposal operations representative of selected dredging sites in Oregon. Reconnaissance data were collected from the Chetco and Rogue River estuaries in southwestern Oregon and from the mouth of the Columbia River in northwestern Oregon to Cathlamet Bay, 18.2 miles upstream.

In an elutriation test, bottom materials from a potential dredge site are mixed with native water - collected from either a dredge or disposal site - and the liquid portion of the mixture is removed, filtered, and chemically analyzed. Presented in this report are chemical and physical analyses of elutriates, native water, and bottom material for selected metals, ammonia, organic carbon, pesticides, particle size, and gas chromatographic/mass spectrometric semi-quantitative organic scans. Elutriate and bottom-material samples were screened specifically for phenolic compounds, particularly the chlorinated phenols; phenol was the only compound identified. Elutriate-test results showed variability for selected trace-metal concentrations of dissolved chemicals as follows: in micrograms per liter, arsenic ranged from <1 to 15, cadmium from 1 to 210, copper from <1 to 13, chromium from <1 to 5, and nickel from 2 to 18.

Comparison of 1982 reconnaissance data from the study with 1980 reconnaissance data shows: (1) 1982 minimum, median, and maximum concentrations for arsenic, cadmium, chromium, nickel, and zinc meet or exceed all 1980 minimum, median, and maximum concentrations for euryhaline elutriates, (2) 1982 minimum, median, and maximum concentrations for cadmium, copper, and nickel meet or exceed all 1980 minimum, median, and maximum concentrations for estuarine elutriates, and (3) 1982 maximum concentrations of DDT, methoxychlor, and perthane exceed 1980 maximum concentrations for bottom-material samples. Particle-size distributions of bottom material ranged from 98 to 2 percent finer than 0.125 mm. Dissolved oxygen and pH were monitored during elutriation tests; variations in dissolved oxygen ranged from near-oxygen saturation to complete-oxygen depletion; variations in pH did not exceed .3 pH units. Results of computations to determine the amount of a constituent associated with bottom material (sediment and interstitial water) and subsequently released (dissolved) into the elutriate-test native mixing water are presented for selected trace metals. The highest elutriate-test release was 35 percent for manganese; the second highest, 5 percent for cadmium. All other computed releases were less than or equal to 1 percent.

INTRODUCTION

The U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers, participated in an elutriation study in April and August of 1982. Elutriation is a process by which bottom materials from a potential dredging site are mixed with native water collected from either a dredge or disposal site and the liquid portion of the mixture is removed, filtered, and chemically analyzed. The elutriation test is a simplified simulation of the various chemical and physical processes that occur when bottom materials are hydraulically dredged and transported as a mixture of bottom material and native water.

The purpose of this report is to present reconnaissance data on elutriates, native water, and bottom material, representative of selected dredging sites, in Oregon. Chemical analyses were made for trace metals, ammonia, major ions, organic carbon, pesticides, and acid/neutral extractable organic compounds. Reconnaissance data were collected from the Chetco and Rogue River estuaries in southwestern Oregon and from the mouth of the Columbia River estuary in northwestern Oregon to Cathlamet Bay, 18.2 miles upstream (fig. 1).

Native water and bottom material were collected by Oregon District personnel from the Geological Survey and Portland District personnel from the Corps of Engineers. Elutriation tests, with the exception of chemical analyses, were conducted at the Geological Survey, Oregon laboratory; samples of native water, elutriates, and bottom material were prepared for chemical analyses and shipped to the Geological Survey Laboratory in Arvada, Colo. Analyses of bottom material for particle-size distribution were made by the Materials Laboratory, U.S. Army Corps of Engineers, North Pacific Division, Troutdale, Ore. Samples were analyzed as follows:

1. Native water and elutriates - for selected trace metals, ammonia, organic carbon, pesticides, acid/neutral extractable organic compounds, hardness, pH, and specific conductance.
2. Bottom material - for selected trace metals, pesticides, acid/neutral extractable organic compounds, percent moisture and particle-size distribution.
3. Elutriation tests - monitored for temperature, pH, and dissolved oxygen.

Field and laboratory procedures will be briefly outlined in this report; for further detail and information on earlier reconnaissance studies see Fuhrer and Rinella (1983). Sampling sites were selected by the Corps of Engineers, and designated as potential dredge or disposal sites. Figure 1 shows names and locations of project areas in Oregon.

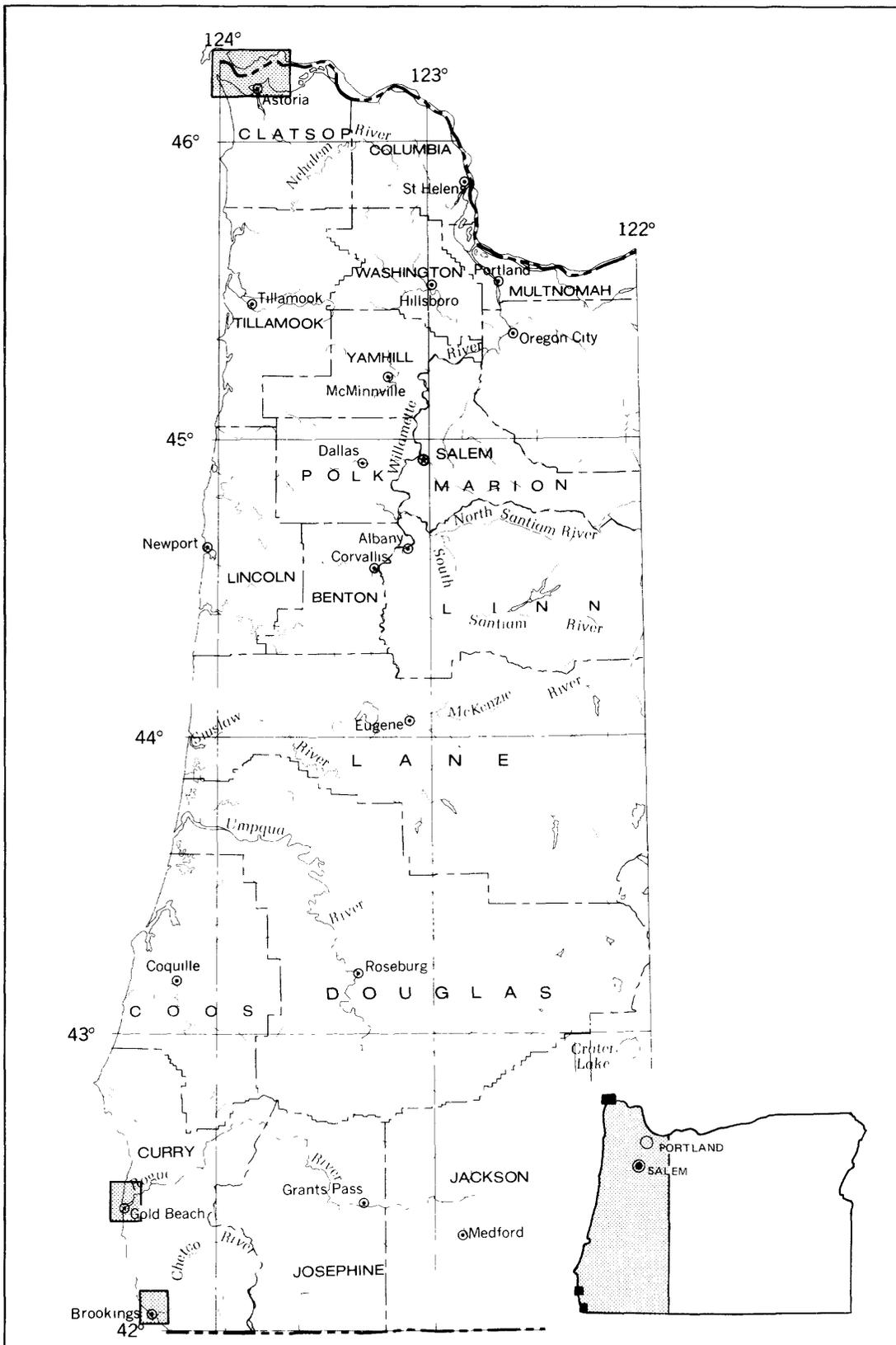


Figure 1.—Locations of the three Oregon project areas.

APPROACH AND METHODOLOGY

As defined by the U.S. Environmental Protection Agency/Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material (Plumb, 1981, p. 2-28), "The elutriate test is a simplified simulation of the dredging and disposal process wherein predetermined amounts of dredging site water and sediment are mixed together to approximate a dredged-material slurry. The elutriate is the supernatant resulting from the vigorous 30-min shaking of one part sediment from the dredging site with four parts water (vol/vol) collected from the dredging site followed by 1-hour settling time and appropriate centrifugation and 0.45 μ m filtration."

Interpretation of the elutriate-test results should consider the following items (Lee and Plumb, 1974):

1. Increases or decreases in chemical concentrations as a result of suspending bottom material from a dredging site with native water from a dredging or disposal site.
2. Background chemical concentrations of disposal-site water as compared to chemical concentrations of the elutriate. Where chemical concentrations exceed 1.5 times the background disposal-site concentrations, special conditions apply to disposal of dredged material. The 1.5 factor does not necessarily represent an increase in chemical concentration that would be harmful to the environment; rather, it indicates that chemical release could occur and that consideration of its impact on the environment is advisable.
3. Factors affecting the elutriation test include (a) solid-to-liquid ratio; (b) length of time bottom material is in contact with native water; (c) pH and dissolved-oxygen changes during the mixing process; (d) method and duration of the mixing process; and (e) atmospheric exposure of bottom material prior to the elutriate test, allowing premature redox reactions to occur.
4. Elutriation test design indicates potential water-column problems, and does not directly indicate toxicity to benthic organisms.

According to M.O. Fretwell (U.S. Geological Survey, written commun., 1981), it is also important, in the interpretation of elutriation-test results to know that bottom-material metal analysis (as determined in this study) is a soft-digestion procedure for determining total recoverable chemicals and is an attempt to simulate bioavailability. Soft digestion involves two steps: (1) preliminary destruction or removal of all organic matter using a 30-percent hydrogen peroxide solution (metals associated with organic material are retained for analyses); and (2) dissolution of all sorbed metals and other minor elements, using a 0.3 molar hot hydrochloric acid solution. This method involves dissolution of all readily available acid-soluble bottom-material components without appreciably attacking the internal matrix of the sediment. Analytical detection limits for dissolved and total recoverable trace metals are presented in table 1.

Table 1.--Detection limits for dissolved and total recoverable constituents

['--' = analyses have not been made]

| Chemical | Detection limit for dissolved, in ug/L | Detection limit for total recoverable, in ug/g |
|-------------------------------------|--|--|
| Arsenic | 1 | 1 |
| Barium | 100 | -- |
| Beryllium | 10 | -- |
| Cadmium | 1 | 1 |
| Chromium | 1 | 1 |
| Copper | 1 | 1 |
| Iron | 1 | 1 |
| Lead | 1 | 10 |
| Manganese | 10 | 1 |
| Mercury | .1 | .01 |
| Nickel | 1 | -- |
| Zinc | 10 | 1 |
| Carbon, total organic ^{1/} | .1 mg/L | -- |
| Nitrogen, ammonia | .01 mg/L | .4 |
| Nitrogen, ammonia + organic | .1 mg/L | -- |
| GC/MS, neutral organics | 1 | <u>2/</u> .1 |
| GC/MS, acid organics | 1 | <u>2/</u> 1 |

1/ Analyses of total organic carbon were made on sample passed through a fiberglass having a nominal pore-size of 10 um.

2/ Approximate detection levels for semi-quantitative GC/MS acid/neutral analyses.

Data and other information for each project include:

- o A map showing sampling-site locations (figs. 3, 6, and 9).
- o A table listing site designations, sampling dates, and site locations by latitude and longitude (tables 4a through 6a).
- o Tables listing results of chemical analyses, including metals, ammonia, organic carbon, particle-size analyses, pesticides, and gas chromatography/mass spectrography (GC/MS) semi-quantitative organic scans (tables 4b-i, 5b-i, and 6b-g).
- o Figures showing dissolved-oxygen concentrations during the one-hour quiescent period of the elutriation test (figs. 4, 7, and 10).
- o Figures showing particle-size distribution of bottom material used in elutriation tests (figs. 5, 8, and 11).

Sample code (tables 4b-i, 5b-i, and 6b-i) is used to identify native water and elutriation samples under a classification scheme of marine, estuarine, euryhaline, and fresh, with salinity and specific conductance boundaries shown in figure 2. In this report, marine samples are considered as estuarine.

Retrieval of chemical data by either the U.S. Geological Survey's WATSTORE (a Water Data STORAGE and RETrieval System) or the Environmental Protection Agency's STORET (STORAGE and RETrieval System) can be made by using a 15-digit station identification number consisting of latitude and longitude, followed by a 2-digit sequence number. The sequence number indicates the type of chemical data to be retrieved from a particular latitude and longitude. The sequence numbers are as follows: 00 for elutriates with river water, 01 for elutriates with ocean water, 02 for bottom material, and 05 for native (river and ocean) water.

FIELD PROCEDURES

Bottom material was collected by a gravity corer or a ponar grab sampler depending on sampling conditions; water samples were collected with a 4-liter Van Dorn sampler. The ponar sampler was used for the Chetco and Rogue Rivers due to adverse weather conditions. The gravity corer was used in the Columbia River; gravity-core sampling is the preferred method since it collects a depth-integrated sample as opposed to a surficial sample by the ponar sampler. Water samples were stored chilled in collapsible plastic containers (polyethylene cubitainers) and bottom-material samples were stored chilled in (butyrate-acetate) plastic cylinders; sampling containers were cleaned with 10-percent hydrochloric acid and rinsed with distilled-deionized water.

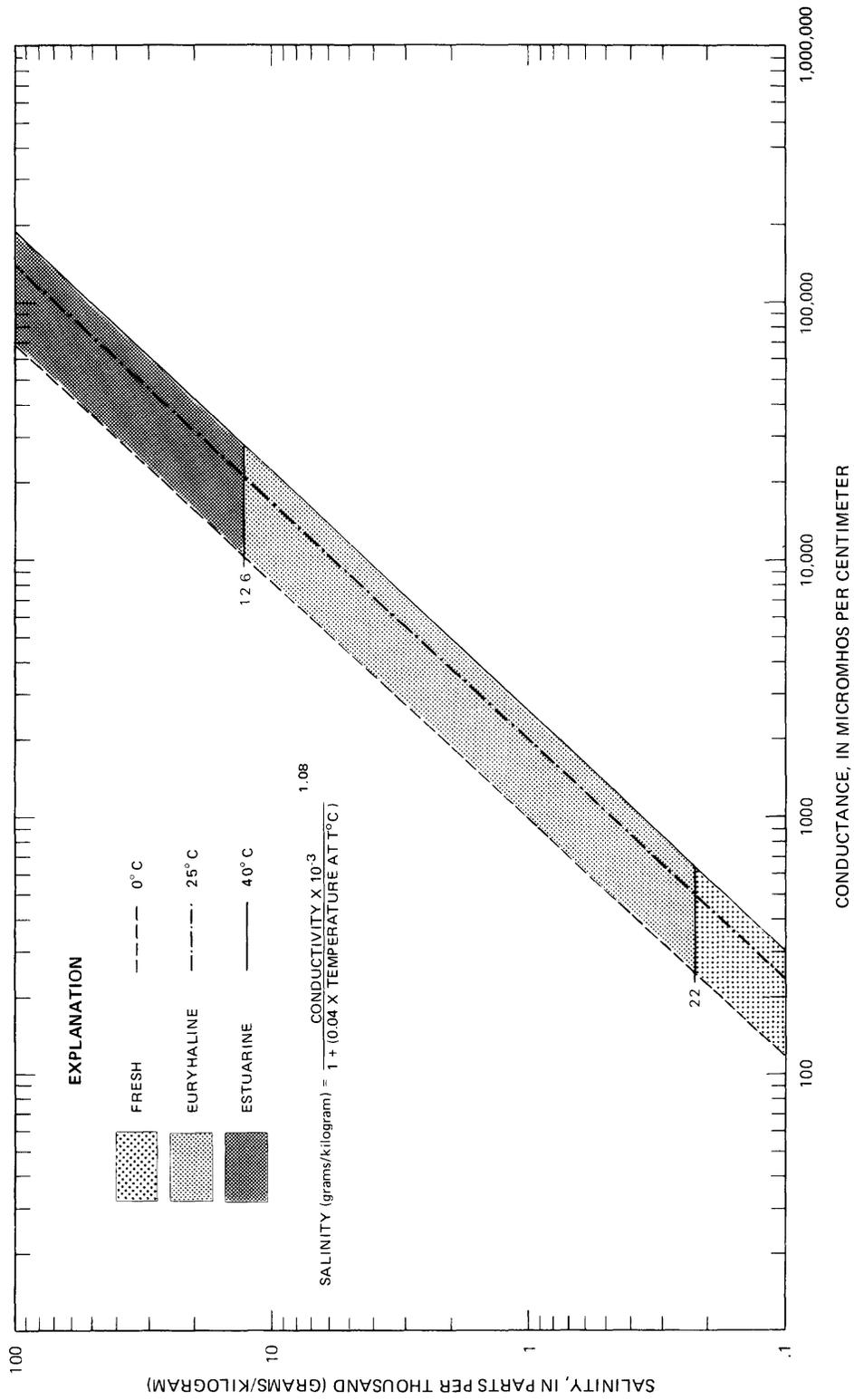


Figure 2.—Salinity and conductance ranges for estuarine, euryhaline, and fresh classifications.

LABORATORY PROCEDURES

Native-water and elutriate samples were analyzed for selected dissolved constituents; bottom-material samples were analyzed for selected total recoverable constituents. The elutriation process involved a 30-minute continuous mechanical mixing of bottom material with native water (volumetric sediment-to-water ratio of 1:4) in a 5-gallon glass carboy. The elutriate sample remained quiescent for 1 hour after mixing; the supernatant was withdrawn and filtered (0.45-um pore-size filter) for analysis of dissolved constituents. Samples for the acid/neutral GC/MS semi-quantitative organic scan were processed in the same manner as processing organic samples described by Fuhrer and Rinella (1983). In addition, samples to be analyzed by the GC/MS scan were protected against bacterial and photochemical degradation by preserving with copper sulfate and phosphoric acid and storing glass sample bottles in styrofoam containers. Samples were refrigerated at 4°C until shipped in ice to the Geological Survey Laboratory in Arvada, Colo., for chemical analyses.

All native-water, elutriate, and bottom-material samples were analyzed as follows:

1. Dissolved trace metals, ammonia, major ions, and all total recoverable constituents were analyzed by the Geological Survey, using methods described by Skougstad and others (1979).
2. Filtered organic and bottom-material samples including pesticides (organochlorine and chlorophenoxy compounds) were analyzed by the Geological Survey, using methods described by Wershaw and others (1983).
3. Particle-size distribution of bottom material was analyzed by the Corps of Engineers using standard sieves approved by the American Society for Testing of Materials.

Immediately following sample filtration of selected samples, specific conductance and pH were measured at the Geological Survey Portland Laboratory, using methods described by Skougstad and others (1979).

The following information is provided to supplement item 2 with respect to semi-quantitative GC/MS analyses for acid/neutral extractable organic constituents in water and bottom material. The method described by Wershaw and others is a modification of the method used in this report as described by Mike Schroeder, U.S. Geological Survey chemist (written and oral commun., 1983).

Native water and elutriate samples were extracted as follows: 100 g of NaCl was added to the water sample and pH was adjusted to <2. The sample was then extracted three times with methylene chloride. A blank was prepared by pre-extracting 900 mL of distilled water then following the same preparation method as for the samples.

The extracts were concentrated and deuterated biphenyl (d_{10} biphenyl) internal standard^{1/} was added to each prior to analysis on a Hewlett-Packard 5985 GC/MS system.

The water extracts were treated with diazomethane to form the methyl esters of the organic acids present in the sample, which are generally more conducive to gas chromatographic analysis than the free acids. Consequently organic acids present in the samples appear as methyl esters in the data tables and are usually not found as such in the environment. The methylation process works well for highly substituted organic acids like chlorinated phenols; however, for some compounds like phenol (present in some of the samples), the methylation process is not complete. In these instances, free phenol appears as free phenol and its diazomethane derivative, anisole. The concentration assigned to free phenol should be considered a minimum value.

Bottom-material samples were prepared as follows: Approximately 15 gm dry weight equivalent of bottom material was subsampled and extracted three times with methylene chloride and acetone, using an ultrasonic probe for sample agitation. Surrogate spiking compounds, 2-fluoro phenol and d_5 -phenol, were used to check recoveries throughout the procedure (see table 2). Surrogate recoveries should be between 30 and 130 percent unless a matrix effect can be demonstrated. The extracts were combined and concentrated to 1.0 mL. D_{10} -biphenyl internal standard was added to the extracts prior to analysis on a Hewlett-Packard 5985 GC/MS system.

^{1/} Use of brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Table 2.--Recovery of surrogate standards 2-fluoro-phenol and d5-phenol added to bottom-material extracts prior to gas chromatography/mass spectography analysis

[The surrogates in this procedure are a methods control (to determine the recovery of a surrogate standard added to the extract) rather than a matrix control (to determine the recovery of a surrogate standard added to the bottom material), BM = bottom-material sample.]

| Site number | Site description | Code | 2-fluoro-phenol | | | d5-phenol | | |
|-------------|------------------|------|-----------------|-------------------|--------------------|----------------|-------------------|--------------------|
| | | | Spiked (ng/uL) | Recovered (ng/uL) | Recovery (percent) | Spiked (ng/uL) | Recovered (ng/uL) | Recovery (percent) |
| 2 | Chetco River | BM | 44 | 43 | 98 | 22 | 23 | 105 |
| 4 | Chetco River | BM | 44 | 22 | 50 | 22 | 16 | 73 |
| 3 | Rogue River | BM | 44 | 74 | 168 | 22 | 34 | 155 |
| 1 | Columbia River | BM | 44 | 27 | 61 | 22 | 14 | 64 |
| 4 | Columbia River | BM | 44 | 32 | 73 | 22 | 19 | 86 |
| 8 | Columbia River | BM | 44 | 27 | 61 | 22 | 14 | 64 |
| 10 | Columbia River | BM | 44 | 25 | 57 | 22 | 16 | 73 |

Chemical extracts from native water, elutriates and bottom-material samples were analyzed as follows: Separation of sample components was done on a 25 m x 0.21 mm ID SE-54 fused silica capillary column held at 35°C for 5 minutes, then programmed to increase at a rate of 10°C per minute to 300°C. The capillary column was coupled directly to the mass spectrometer, which was set to analyze from 40-450 atomic mass units with a scan time of 0.5 seconds. Spectra corresponding to gas chromatographic peak maxima were compared by computerized library search with the National Bureau of Standards Library Reference Spectra (NBSLRS). The best library matches were selected according to a "match factor" - a parameter used by the Hewlett-Packard library search algorithm to indicate the quality of the match between the sample and library spectra. Generally, the closer the match factor is to 1.00, the better the library match. The best computer matches were compared with the sample spectrum manually to ensure the best possible identification. Tables 4e, 4h, 5e, 5h, 6d, and 6f show match factors less than .9 in parenthesis following the reported concentrations. Compounds identified were then categorized according to the certainty of identification, taking into consideration standards run, library matches, and whether they were present in the blank, or in the wrong chemical fraction. The NBSLRS does not contain spectra for all organic compounds or their isomers. Spectrum matches with NBSLRS could have improved match factors if all the isomers of organic compounds referenced in the NBSLRS were present. As an example, a spectrum match identified as 3,4-dichlorobenzoic acid (reported in table 5 with a match factor of 0.83) could possibly be another isomer; however, at present, 3,4-dichlorobenzoic acid is the only dichlorobenzoic acid isomer present in the NBSLRS.

Compound concentrations are reported in ug/L (waters) or mg/kg (bottom materials) calculated relative to the concentration of the d₁₀-biphenyl internal standard. Deuterated biphenyl is a common standard used for semi-quantitative GC/MS analyses; constituents analyzed by semi-quantitative methods are accurate to + or - 100 percent of the reported value. For detection limits of acid/neutral organic compounds, see table 1. Pesticide compounds in bottom material would be detected by semi-quantitative GC/MS analyses if present in concentrations greater than 200 to 300 ug/kg.

The samples were all screened specifically for phenolic compounds, particularly the chlorinated phenols. Among those compounds detected in the elutriation test, phenol was the only compound identified, as indicated in the data tables.

MONITORING ELUTRIATE-TEST CONDITIONS

Temperature, pH, and dissolved oxygen were monitored (in the upper layer of the elutriate-test mixture) during the one-hour quiescent period following the 30-minute mixing of the elutriate sample. Monitoring data can provide essential information describing chemical-reaction conditions prevalent during individual elutriation tests (Jones and Lee, 1978).

Measurements of temperature and dissolved oxygen were made using a Yellow Springs instrument model 57 oxygen meter; pH measurements were made using an Orion Research model 601-A Digital Ionalyzer with an Orion Research 91-04 pH probe.

Temperature

Native-water samples are stored at 4°C in refrigeration units and equilibrated to room temperature prior to elutriation tests. Measured temperature variations were less than 1°C during elutriation tests (tables 4c through 6c).

pH

The largest measured fluctuation in pH, +.3 pH units, was observed in an elutriation test made with bottom material sampled from site number 3 on the Rogue River. All other measured fluctuations were equal to, or less than, +.1 pH units. The highest and lowest pH measurements, 8.2 and 6.7 pH units, were recorded from elutriation tests made with bottom material sampled from site number 11 on the Columbia River and site number 4 on the Chetco River, respectively. Measurements of pH shown in tables 4c through 6c represent the final pH value at the end of the 60-minute quiescent period.

Dissolved Oxygen

Dissolved-oxygen concentrations in the elutriation test ranged from complete saturation (oxic conditions) to complete depletion (anoxic conditions). Graphs of dissolved-oxygen concentration versus time are presented in figures 4, 7, and 10. Figures 4, 7, and 10 also show dissolved-oxygen saturation - maximum oxygen concentration in water at a given temperature and salinity that is in equilibrium with atmospheric pressure - prior to the 30-minute mixing of the elutriation test.

Depending on the bottom material, some elutriation tests became anoxic during the 30-minute mixing period, the 1-hour quiescent period, or remained oxic for the duration of the elutriate test. The 30-minute mixing period provides some reaeration to the elutriate sample; however, some elutriate samples became anoxic during the mixing process (fig. 7, site 3 and fig. 10, site 10). Other elutriate tests became anoxic during the 1-hour quiescent period (fig. 4, sites 3 and 4).

Elutriation-test dissolved-oxygen conditions are summarized in tables 4c through 6c by using a qualitative variable "REDOX CONDITIONS" with a value of O or R for oxidizing or reducing conditions, respectively. This information is helpful in evaluating elutriation-test results since many particulate/trace metal interactions are influenced by redox conditions (Bender, 1981)

STATISTICAL COMPARISON OF 1980 AND 1982 RECONNAISSANCE DATA

Frequency distributions of elutriation and bottom-material data often are assymetric and have a few extreme scores; these distributions are better represented by counting methods like quartiles where the median is the best measure of central tendency (Byrkit, 1972). Quartiles have been generated in table 3 for 1980 reconnaissance data (Fuhrer and Rinella, 1983) and 1982 reconnaissance data. Reconnaissance data from 1980 were collected and analyzed from Oregon estuaries in a similar manner to 1982 reconnaissance data presented in tables 4b-i, 5b-i, and 6b-i. Comparisons have been made based on the estuarine and euryhaline classifications of figure 2 for elutriation data.

The following elutriation constituents for 1982 reconnaissance data meet or exceed minimum, median, and maximum constituent concentrations of 1980 reconnaissance data for euryhaline and (or) estuarine classifications established for elutriation data:

- o arsenic, exceeds euryhaline classifications
- o cadmium, exceeds euryhaline and estuarine classifications
- o copper, exceeds estuarine classification
- o chromium, exceeds euryhaline classification
- o nickel, exceeds euryhaline and estuarine classification
- o zinc, exceeds euryhaline classification

The following constituents for 1982 reconnaissance data have one or more values exceeding maximum constituent concentrations for 1980 elutriation and bottom-material reconnaissance data:

- o barium, 400 ug/L, euryhaline classification maximum
- o DDT, 1.9 ug/kg, bottom-material maximum
- o perthane, 1 ug/kg, bottom-material maximum
- o methoxychlor, .7 and 1.5 ug/kg, bottom-material maximum

TRACE-METAL RELEASE FROM BOTTOM MATERIAL TO ELUTRIATION-TEST MIXING WATER

Results of computations to determine elutriate-test release are presented in table 6h. These calculations indicate the amount of a constituent (by weight) associated with bottom material (sediments and interstitial water) that is subsequently released (dissolved) into the elutriate-test native mixing water. During an elutriation-test mixing and settling period, a variety of bottom-material/mixing-water interactions occur based on physical-chemical conditions. Results of these interactions within a single elutriation test are determined by comparing trace-metal concentrations of elutriate-test filtrate and native mixing water.

Table 3.--Statistical summary of elutriate and bottom material data from the 1980 reconnaissance study versus the 1982 reconnaissance study

Summary statistics are presented for elutriates based on euryhaline and estuarine classifications from figure 2; minimum, median, and maximum statistics are presented when n is less than 7; minimum, Q-1, median, Q-3, and maximum statistics are presented when n is greater than or equal to 7; '--' indicates chemical or statistical analyses have not been made; '*' indicates 1982 euryhaline and (or) estuarine minimum, median, and maximum values are greater than or equal to 1980 values; elutriate and bottom-material concentrations are reported in units of micrograms per liter and micrograms per kilogram, respectively, except where indicated.

| | Elutriate with euryhaline water 1980 reconnaissance data | | | | | | Elutriate with euryhaline water 1982 reconnaissance data | | | | | |
|--------------------------------|---|-----|--------|------|------|----|---|-----|--------|-----|------|----|
| | min | Q-1 | median | Q-3 | max | n | min | Q-1 | median | Q-3 | max | n |
| Cadmium* | <1 | <1 | <1 | <1 | 1 | 29 | 1 | -- | 1 | -- | 1 | 3 |
| Chromium* | <1 | <1 | <1 | <1 | 1 | 26 | 1 | -- | 2 | -- | 5 | 4 |
| Copper | <1 | 1 | 2 | 3 | 19 | 29 | <1 | -- | 1 | -- | 4 | 4 |
| Iron | 10 | 25 | 40 | 60 | 770 | 29 | 80 | -- | 170 | -- | 840 | 4 |
| Lead | <1 | <1 | <1 | 2.0 | 5 | 29 | <1 | -- | 1 | -- | 1 | 4 |
| Manganese | 10 | 30 | 80 | 190 | 1300 | 29 | 70 | -- | 180 | -- | 5300 | 4 |
| Mercury | <.1 | <.1 | .1 | .2 | .6 | 29 | <.1 | -- | 1 | -- | .2 | 4 |
| Zinc* | 1.2 | 3.8 | 10 | 10 | 40 | 29 | 10 | -- | 15 | -- | 61 | 4 |
| Total Organic Carbon mg/L | 3.4 | 9.8 | 14 | 23.5 | 35 | 29 | 8.1 | -- | 9.8 | -- | 13 | 4 |
| Nitrogen, Ammonia as N mg/L | .04 | .74 | 1.4 | 7.5 | 19 | 29 | 1.7 | -- | 2.6 | -- | 3.6 | 4 |
| Phenols | <1 | 17 | 40 | 160 | 380 | 28 | -- | -- | -- | -- | -- | -- |
| Arsenic* | 2 | -- | 2 | -- | 5 | 6 | 4 | -- | 6 | -- | 15 | 4 |
| Barium | <100 | -- | <100 | -- | 100 | 6 | <100 | -- | <100 | -- | 400 | 4 |
| Beryllium | <10 | -- | <10 | -- | 10 | 5 | <10 | -- | <10 | -- | <10 | 4 |
| Nickel* | <1 | -- | 1.5 | -- | 2 | 6 | 4 | -- | 10 | -- | 18 | 4 |
| Kjeldahl mg/L | 1.5 | -- | 4.9 | -- | 11 | 6 | -- | -- | -- | -- | -- | -- |
| Aldrin | <.01 | -- | <.01 | -- | <.01 | 6 | <.01 | -- | <.01 | -- | <.01 | 4 |
| Chlordane | <.1 | -- | <.1 | -- | <.1 | 6 | <.1 | -- | <.1 | -- | <.1 | 4 |
| DDD | <.01 | -- | <.01 | -- | <.01 | 6 | <.01 | -- | <.01 | -- | <.01 | 4 |
| DDE | <.01 | -- | <.01 | -- | <.01 | 6 | <.01 | -- | <.01 | -- | <.01 | 4 |
| DDT | <.01 | -- | <.01 | -- | <.01 | 6 | <.01 | -- | <.01 | -- | <.01 | 4 |
| Dieldrin | <.01 | -- | <.01 | -- | <.01 | 6 | <.01 | -- | <.01 | -- | <.01 | 4 |
| Endosulfan | <.01 | -- | <.01 | -- | <.01 | 6 | <.01 | -- | <.01 | -- | <.01 | 4 |
| Endrine | <.01 | -- | <.01 | -- | <.01 | 6 | <.01 | -- | <.01 | -- | <.01 | 4 |
| Heptachlor | <.01 | -- | <.01 | -- | <.01 | 6 | <.01 | -- | <.01 | -- | <.01 | 4 |
| Lindane | <.01 | -- | <.01 | -- | <.01 | 6 | <.01 | -- | <.01 | -- | <.01 | 4 |
| Methoxychlor | <.01 | -- | <.01 | -- | <.01 | 6 | -- | -- | -- | -- | -- | -- |
| Mirex | <.01 | -- | <.01 | -- | <.01 | 6 | <.01 | -- | <.01 | -- | <.01 | 4 |
| PCB | <.1 | -- | <.1 | -- | <.1 | 6 | <.1 | -- | <.1 | -- | <.1 | 4 |
| PCN | <.1 | -- | <.1 | -- | <.1 | 6 | <.1 | -- | <.1 | -- | <.1 | 4 |
| Perthane | <.1 | -- | <.1 | -- | <.1 | 6 | <.1 | -- | <.1 | -- | <.1 | 4 |
| Silvex | <.01 | -- | <.01 | -- | <.01 | 6 | <.01 | -- | <.01 | -- | <.01 | 3 |
| Toxaphene | <1 | -- | <1 | -- | <1 | 6 | <1 | -- | <1 | -- | <1 | 4 |
| 2,4-D | <.01 | -- | <.01 | -- | .04 | 6 | <.01 | -- | <.01 | -- | <.01 | 3 |
| 2,4-DP | <.01 | -- | <.01 | -- | <.01 | 5 | <.01 | -- | <.01 | -- | <.01 | 4 |
| 2,4,5-T | <.01 | -- | <.01 | -- | .01 | 6 | <.01 | -- | <.01 | -- | <.01 | 3 |

Table 3.--Statistical summary of elutriate and bottom material data from the 1980 reconnaissance study versus the 1982 reconnaissance study--Continued

| | Elutriate with estuarine water 1980 reconnaissance data 1/ | | | | | | Elutriate with estuarine water 1982 reconnaissance data 2/ | | | | | |
|--------------------------------|---|------|--------|------|-------|----|---|-----|--------|-----|-------|----|
| | min | Q-1 | median | Q-3 | max | n | min | Q-1 | median | Q-3 | max | n |
| Cadmium* | <1 | <1 | <1 | 1 | 3 | 54 | 1 | -- | 4 | -- | 210 | 4 |
| Chromium | <1 | <1 | <1 | <1 | 40 | 54 | <1 | -- | <1 | -- | <1 | 4 |
| Copper* | <1 | <1 | 1 | 3 | 11 | 56 | <1 | -- | 1 | -- | 13 | 4 |
| Iron | 50 | 88 | 140 | 170 | 4300 | 56 | 160 | -- | 180 | -- | 350 | 4 |
| Lead | <1 | <1 | <1 | 1 | 4 | 56 | <1 | -- | <1 | -- | <1 | 4 |
| Manganese | 20 | 160 | 480 | 1500 | 10000 | 56 | 40 | -- | 440 | -- | 15000 | 4 |
| Mercury | <.1 | <.1 | <.1 | .1 | .7 | 56 | <.1 | -- | <.1 | -- | <.1 | 4 |
| Zinc | 1.2 | 20 | 30 | 40 | 90 | 56 | 30 | -- | 40 | -- | 40 | 4 |
| Total Organic Carbon mg/L | .5 | 3.4 | 5.6 | 11 | 20 | 56 | 2 | -- | 3.1 | -- | 5.5 | 4 |
| Nitrogen, Ammonia as N mg/L | .03 | .38 | 1.4 | 4.5 | 46 | 51 | .09 | -- | .38 | -- | 7 | 4 |
| Phenols | <1 | 8 | 23 | 46 | 420 | 55 | 1 | -- | 26 | -- | 260 | 4 |
| Arsenic | 1 | 1 | 2 | 3 | 4 | 15 | <1 | -- | 1 | -- | 1 | 4 |
| Barium | <100 | 175 | 350 | 650 | 1500 | 14 | <100 | -- | <100 | -- | <100 | 4 |
| Beryllium | <10 | 10 | 10 | 20 | 20 | 15 | <10 | -- | <10 | -- | <10 | 4 |
| Nickel* | <1 | 3 | 4 | 10 | 11 | 15 | 2 | -- | 6.0 | -- | 16 | 4 |
| Kjeldahl mg/L | .46 | 1.2 | 2.9 | 15 | 36 | 11 | .9 | -- | 1.2 | -- | 6.4 | 4 |
| Aldrin | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| Chlordane | <.1 | <.1 | <.1 | <.1 | <.1 | 13 | -- | -- | -- | -- | -- | -- |
| DDD | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| DDE | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| DDT | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| Dieldrin | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| Endosulfan | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| Endrine | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| Heptachlor | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| Lindane | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| Methoxychlor | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| Mirex | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| PCB | <.1 | <.1 | <.1 | <.1 | <.1 | 13 | -- | -- | -- | -- | -- | -- |
| PCN | <.1 | <.1 | <.1 | <.1 | <.1 | 13 | -- | -- | -- | -- | -- | -- |
| Perthane | <.1 | <.1 | <.1 | <.1 | <.1 | 13 | -- | -- | -- | -- | -- | -- |
| Silvex | <.01 | <.01 | <.01 | <.01 | .01 | 13 | -- | -- | -- | -- | -- | -- |
| Toxaphene | <1 | <1 | <1 | <1 | <1 | 13 | -- | -- | -- | -- | -- | -- |
| 2,4-D | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| 2,4-DP | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |
| 2,4,5-T | <.01 | <.01 | <.01 | <.01 | <.01 | 13 | -- | -- | -- | -- | -- | -- |

Table 3.--Statistical summary of elutriate and bottom material data from the 1980 reconnaissance study versus the 1982 reconnaissance study--Continued

| | Bottom material 1980 reconnaissance data <u>1/</u> | | | | | | Bottom material 1982 reconnaissance data <u>3/</u> | | | | | |
|--------------------------|---|------|--------|-------|-------|----|---|------|--------|------|-------|----|
| | min | Q-1 | median | Q-3 | max | n | min | Q-1 | median | Q-3 | max | n |
| Arsenic | <1 | 2 | 4 | 8 | 12 | 28 | 2 | 2 | 3 | 6 | 9 | 14 |
| Cadmium | <1 | <1 | 1 | 2 | 29 | 28 | <10 | <10 | <10 | <10 | 10 | 14 |
| Chromium | 1 | 6 | 12 | 15 | 30 | 28 | 1 | 2 | 3 | 20 | 30 | 7 |
| Copper | 4 | 7 | 13 | 35 | 180 | 28 | 1 | 2 | 19 | 37 | 72 | 7 |
| Iron | 1400 | 6000 | 9200 | 16000 | 31000 | 28 | 1800 | 3300 | 4200 | 5100 | 20000 | 14 |
| Lead | <10 | 10 | 10 | 18 | 40 | 28 | <100 | <100 | <100 | <100 | <100 | 7 |
| Manganese | 32 | 90 | 140 | 200 | 420 | 28 | 40 | 64 | 85 | 220 | 350 | 14 |
| Mercury | <.01 | .02 | .03 | .06 | .28 | 28 | <.01 | .01 | .06 | .14 | .15 | 7 |
| Zinc | 4 | 22 | 36 | 110 | 31000 | 28 | 8 | 13 | 22 | 41 | 85 | 7 |
| Carbon Inorganic g/kg | -- | -- | .1 | .38 | 4.1 | 28 | -- | -- | -- | -- | -- | -- |
| Carbon Total g/kg | .6 | 1.38 | 6.2 | 20 | 133 | 28 | -- | -- | -- | -- | -- | -- |
| Aldrin | <.1 | <.1 | <.1 | <.1 | 1.5 | 27 | <.1 | -- | <.1 | -- | <.1 | 3 |
| Chlordane | <1 | <1 | <1 | <1 | 4 | 28 | <1 | -- | 1 | -- | 2 | 3 |
| DDD | <.1 | <.1 | .1 | .4 | 11 | 28 | <.1 | -- | .1 | -- | 1 | 3 |
| DDE | <.1 | <.1 | <.1 | .4 | 6.8 | 28 | <.1 | -- | .1 | -- | 2.3 | 3 |
| DDT | <.1 | <.1 | <.1 | <.1 | 1 | 28 | <.1 | -- | <.1 | -- | 1.9 | 3 |
| Dieldrin | <.1 | <.1 | <.1 | <.1 | .5 | 28 | <.1 | -- | .1 | -- | .1 | 3 |
| Endosulfan | <.1 | <.1 | <.1 | <.1 | <.1 | 26 | <.1 | -- | <.1 | -- | <.1 | 3 |
| Endrine | <.1 | <.1 | <.1 | <.1 | <.1 | 28 | <.1 | -- | <.1 | -- | <.1 | 3 |
| Heptachlor | <.1 | <.1 | <.1 | <.1 | .2 | 28 | <.1 | -- | <.1 | -- | <.1 | 3 |
| Heptachlor Epoxide | <.1 | <.1 | <.1 | <.1 | <.1 | 28 | <.1 | -- | <.1 | -- | <.1 | 3 |
| Lindane | <.1 | <.1 | <.1 | <.1 | .4 | 28 | <.1 | -- | <.1 | -- | .1 | 3 |
| Methoxychlor | <.1 | <.1 | <.1 | <.1 | <.1 | 27 | <.1 | -- | .7 | -- | 1.5 | 3 |
| Mirex | <.1 | <.1 | <.1 | <.1 | <.1 | 26 | <.1 | -- | <.1 | -- | <.1 | 3 |
| PCB | <1 | <1 | <1 | 11 | 56 | 27 | 1 | -- | 2 | -- | 5 | 3 |
| PCN | <1 | <1 | <1 | <1 | <1 | 11 | <1 | -- | <1 | -- | <1 | 3 |
| Perthane | <1 | <1 | <1 | <1 | <1 | 26 | <1 | -- | <1 | -- | 1 | 3 |
| Silvex | <.1 | <.1 | <.1 | <.1 | <.1 | 28 | -- | -- | -- | -- | -- | -- |
| Toxaphene | <10 | <10 | <10 | <10 | <10 | 28 | <10 | -- | <10 | -- | <10 | 3 |
| 2,4-D | <.1 | <.1 | <.1 | <.1 | <.1 | 28 | -- | -- | -- | -- | -- | -- |
| 2,4-DP | <.1 | <.1 | <.1 | <.1 | <.1 | 9 | -- | -- | -- | -- | -- | -- |
| 2,4,5-T | <.1 | <.1 | <.1 | <.1 | <.1 | 26 | -- | -- | -- | -- | -- | -- |

1/ Fuhrer and Rinella, 1983.

2/ Pesticide analyses were not made for 1982 elutriates with estuarine water (Columbia River Project).

3/ Pesticide analyses were not made for 1982 Columbia River bottom material; herbicide analyses were not made on any 1982 projects.

To compare elutriate-test release between two or more elutriation tests, the dry weight of bottom material must be considered. This weight is dependent on the percent moisture of the bottom-material sample. Since the elutriation test is determined volumetrically, (1 part bottom material to 4 parts water), the ratio of the dry weight of bottom material and associated trace metals to mixing water will vary as the percent moisture of the bottom material varies. To calculate elutriate-test release, the following factors must be determined: (1) constituent concentration in elutriate-test filtrate, (2) constituent concentration in elutriate-test native mixing water, (3) percent moisture of bottom material, (4) mass of bottom material (wet weight), (5) trace-metal concentration of bottom material (dry weight), and (6) volume of elutriate-test native mixing water.

The release of selected trace metals associated with bottom material to elutriate-test native mixing water, in percent, is calculated as follows:

$$\begin{aligned} \text{Elutriation-test} \\ \text{release} \\ \text{(in percent)} \end{aligned} = \frac{(E_c - W_c) \times W_v}{B_m \times (1 - (M\%/100)) \times B_c} \times 100$$

where,

E_c = concentration of trace metal in elutriate-test filtrate, in microgram per liter,
 W_c = concentration of trace metal in elutriate-test native mixing water, in micrograms per liter,
 B_m = mass of bottom material in elutriation test (wet weight),
 $M\%$ = percent moisture of bottom material in elutriation test,
 B_c = total recoverable concentration of trace metal in bottom material, in micrograms per gram, and
 W_v = volume of elutriate-test native mixing water.

The following example shows how elutriation-test release has been computed for manganese at Cathlamet Bay site 10 (table 6h)

where,

E_c = 15,000 micrograms per liter,
 W_c = 40 micrograms per liter,
 B_m = 5,048 grams, wet weight,
 $M\%$ = 35 percent,
 B_c = 160 micrograms per gram, and
 W_v = 12.26 liters.

$$\begin{aligned} \text{Elutriation-test} \\ \text{release} \\ \text{(in percent)} \end{aligned} = \frac{15,000 \text{ ug/L} - 40 \text{ ug/L} \times 12.26 \text{ L}}{5,040 \text{ g} \times (1 - (35/100)) \times 160 \text{ ug/g}} \times 100$$

$$\begin{aligned} \text{Elutriation-test} \\ \text{release} \\ \text{(in percent)} \end{aligned} = \frac{183,410 \text{ ug}}{524,160 \text{ ug}} \times 100 = 35 \text{ percent}$$

An elutriate-test release of 35 percent indicates that of the 160 ug/g manganese in bottom sediment and interstitial water, 35 percent or 56 ug/g of manganese will be released into the elutriate-test filtrate. Due to the uncertainties of analytical precision and reporting levels, elutriation-test releases are reported to the nearest 1 percent. Computations of elutriation-test release are based on "total recoverable" trace-metal concentrations in bottom material described earlier (Fretwell, written commun., 1981).

Table 6h shows highest computed elutriation-test release, 35 percent for manganese, occurred at Cathlamet Bay site number 10; all Columbia River elutriation tests, with the exception of site number 1, show an elutriation-test release of manganese. The second highest elutriation-test release, 5 percent for cadmium, occurred at site number 1.

SUMMARY OF RESULTS

This report presents reconnaissance data on elutriates, native water, and bottom material, representative of selected dredging sites in Oregon. Comparison of reconnaissance data from this study with other Oregon estuary reconnaissance data (Fuhrer and Rinella, 1983), indicates the following: (1) arsenic, cadmium, chromium, nickel, and zinc euryhaline elutriate concentrations meet or exceed minimum, median, and maximum values of 1980 euryhaline elutriate reconnaissance data, (2) cadmium, copper, and nickel estuarine elutriate concentrations meet or exceed minimum, median, and maximum values of 1980 estuarine elutriate reconnaissance data, and (3) DDT, perthane, and methoxychlor bottom-material concentrations have one or more values exceeding maximum constituent concentrations for 1980 bottom-material reconnaissance data. Particle-size distributions of bottom material ranged from 98-percent finer than 0.125 mm to 2-percent finer than .125 mm diameter.

Native water, elutriate, and bottom-material samples were all screened specifically for phenolic compounds, particularly the chlorinated phenols. Among those compounds detected in the elutriation test, phenol was the only compound identified, as indicated in the data tables.

Temperature, pH, and dissolved oxygen were monitored during the one-hour quiescent period of the elutriation test. Temperature variations did not exceed 1°C; pH fluctuations did not exceed .3 pH units; and pH measurements of 8.2 and 6.7 were the maximum and minimum measured pH values. Dissolved-oxygen measurements made during the one-hour quiescent period indicate: one of four Columbia River, one of two Rogue River and two of three Chetco River elutriation tests were made under anoxic conditions.

Elutriate-test release of trace metals from bottom material to elutriate-test mixing water was computed for selected trace metals. The highest elutriate-test release was 35 percent for manganese; the second highest, 5 percent for cadmium. All other computed elutriate-test releases were less than or equal to 1 percent.

SELECTED REFERENCES

- Bender, M. D., 1981, Nearshore marine trace metal geochemistry: Virginia, National Technical Information Service, Document No. PB82 10 937 2, 96 p.
- Byrkit, D. B., 1972, Elements of statistics (2d ed.): New York, Van Nostrand Reinhold Co., p. 39.
- Fuhrer, G. F., and Rinella, F. A., 1983, Analyses of elutriates, native water, and bottom material in selected rivers and estuaries in western Oregon and Washington: U.S. Geological Survey Open-File Report 82-923, 147 p.
- Jones, A. R., and Lee, G. F., 1978, Evaluation of the elutriation test as a method of predicting contaminant release during open-water disposal of dredged material and environmental impact of open-water dredged material disposal: Vicksburg, Miss., U.S. Army Waterways Experimental Station, Office Of Dredged Material Research, Technical Report D-78-45.
- Lee, G. F., and Plumb, R. H., 1974, Literature review on research study for the development of dredged material disposal criteria: Vicksburg, Miss., U.S. Army Engineer Waterways Experiment Station, Office of Dredged Material Research, Miscellaneous Paper D-74-1.
- Plumb, R. H., Jr., 1981, Procedure for handling and chemical analysis of sediment and water samples: Technical Report EPA/CE-81-1, Prepared by Great Lakes Laboratory, State University College at Buffalo, N.Y., for the U.S. Environmental Protection Agency/Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material. Published by the U.S. Army Engineers Waterways Experimental Station, Corps of Engineers, Vicksburg, Miss., p. 2-28.
- Skougstad, M. W., Fishman, M. J., Friedman, L. D., Erdmann, D. E., and Duncan, S. S., eds., 1979, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chap. A1, 625 p.
- Wershaw, R. L., Fishman, M. J., Grabbe, R. R., and Lowe, L. E., 1983, Methods for the determination of organic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Laboratory Analysis, Chapter A3, Open-File Report 82-1004, Denver, Colo., 173 p.

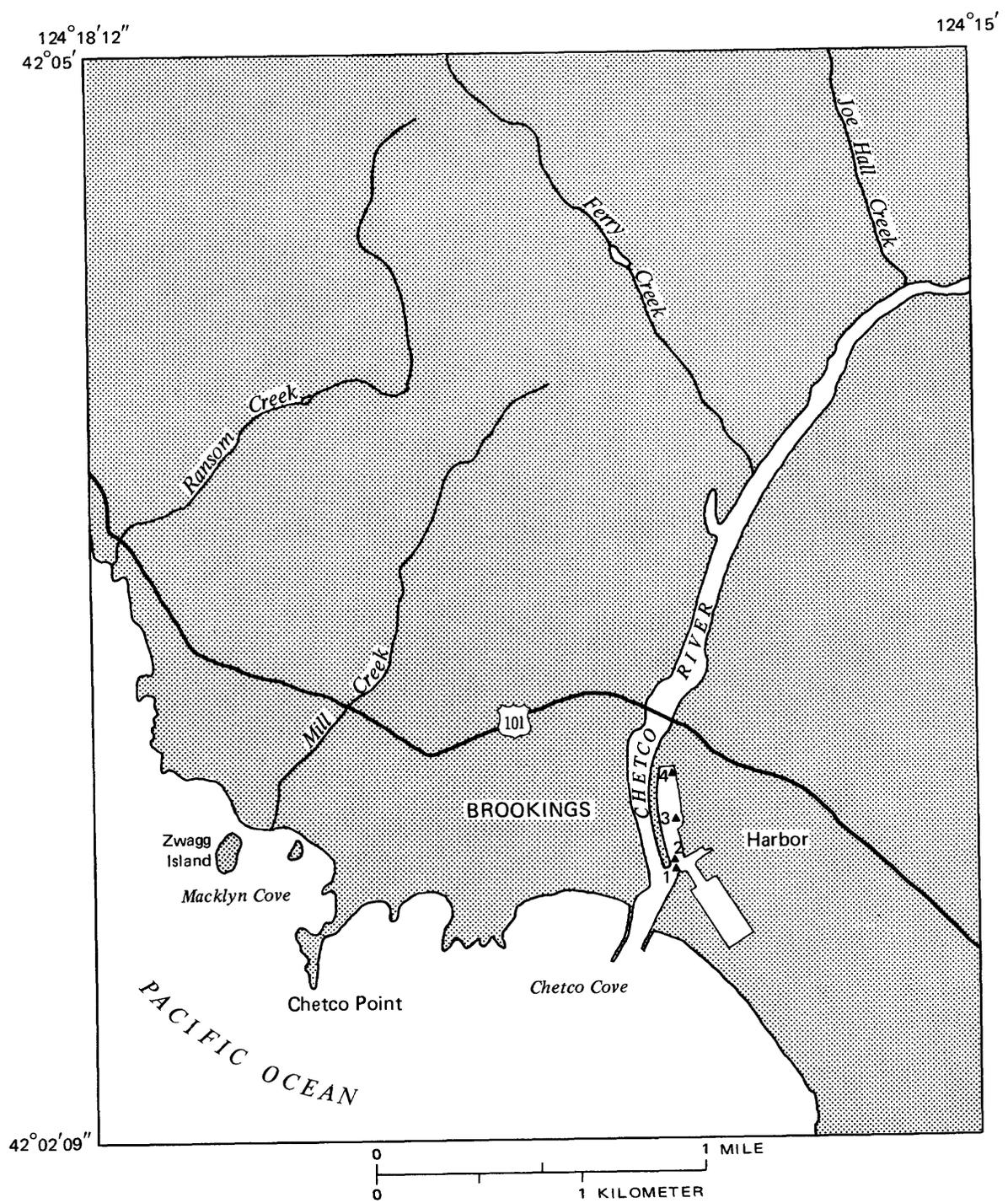


Figure 3.—Sampling sites for the Chetco River, Oregon.

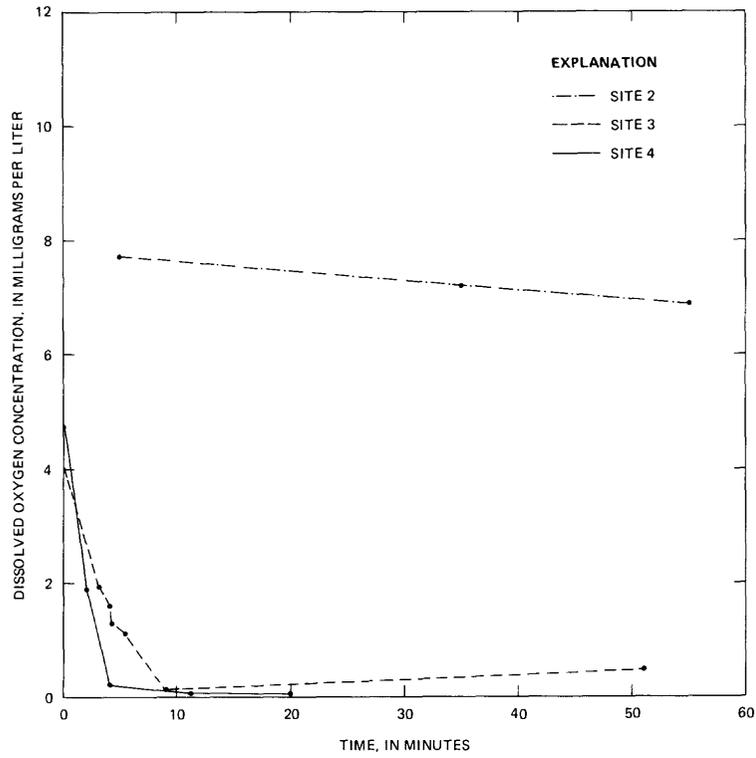


Figure 4.—Dissolved oxygen concentration versus time for Chetco River elutriate samples following the 30 minute mixing period. (Dissolved oxygen concentration at 100 percent saturation is 9.5 mg/L at site 2, 9.6 mg/L at site 3, and 10.7 mg/L at site 4.)

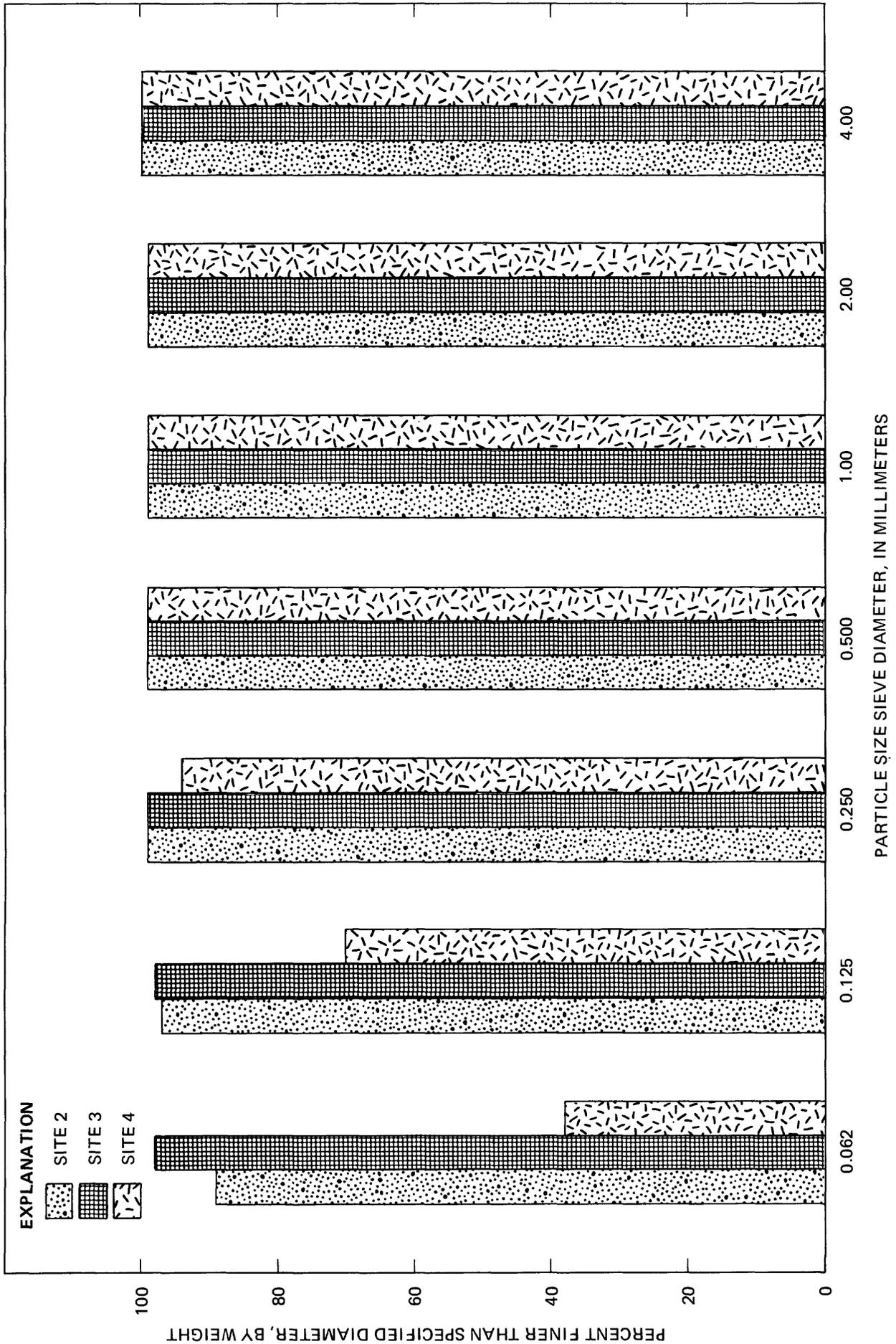


Figure 5.—Particle size distribution of bottom material from Chetco River sampling sites 2, 3, and 4.

Table 4a.--Location of sampling sites, Cheto River, Oreg., project

| Site no. | Site designation | Collection date | Site location | | Remarks |
|----------|------------------|-----------------|---------------|------------|---|
| | | | Latitude | Longitude | |
| 1 | Cheto River | 04-06-82 | 42°02'48" | 124°16'01" | Water sample only. All sampling sites are within the turning basin (RM 0.3). |
| 2 | do. | do. | 42°02'51" | 124°16'02" | |
| 3 | do. | do. | 42°02'56" | 124°16'06" | |
| 4 | do. | do. | 42°03'03" | 124°16'08" | |

TABLE 4b.--CHETCO RIVER, OREGON PROJECT

DISSOLVED CHEMICALS IN NATIVE WATER AND ELUTRIATES

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| S I T E NO. | C O D E | SITE DESCRIPTION | DATE | CHROMIUM | | COPPER | | IRON | | LEAD | | MANGANESE | | MERCURY | | ZINC | | CARBON, ORGANIC | | NITROGEN, AMMONIA | |
|-------------------------|------------------|---------------------|------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|----------------|--------------------|--|----------------------|--|
| | | | | (UG/L AS CR) | (UG/L AS CR) | (UG/L AS CU) | (UG/L AS CU) | (UG/L AS FE) | (UG/L AS FE) | (UG/L AS PB) | (UG/L AS MN) | (UG/L AS HG) | (UG/L AS HG) | (UG/L AS ZN) | (MG/L AS C) | (MG/L AS C) | (MG/L AS N) | (MG/L AS N) | | | |
| 1 | | CHETCO RIVER | NH | 04/06/82 | <3 | 4 | 2 | 44 | <1 | 28 | <0.1 | <12 | 0.7 | 0.06 | | | | | | | |
| 2 | | CHETCO RIVER | EH | 04/06/82 | 1 | 3 | <1 | 80 | 1 | 5300 | 0.1 | 20 | 8.5 | 3.60 | | | | | | | |
| 3 | | CHETCO RIVER | EH | 04/06/82 | 1 | 1 | 1 | 150 | 1 | 130 | <0.1 | 10 | 8.1 | 2.60 | | | | | | | |
| 4 | | CHETCO RIVER | EH | 04/06/82 | 1 | 1 | 1 | 190 | 1 | 70 | 0.2 | 10 | 11.0 | 2.70 | | | | | | | |

TABLE 4c.--CHETCO RIVER, OREGON PROJECT

ADDITIONAL DISSOLVED CHEMICALS IN NATIVE WATER AND ELUTRIATES

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| S I T E N O. | C O D E | S I T E D E S C R I P T I O N | D A T E | A R S E N I C (U G / L A S A S) | B A R I U M (U G / L A S B A) | B E R Y L L I U M (U G / L A S B E) | N I C K E L (U G / L A S N I) | N I T R O - G E N A M - M O N I A + O R G A N I C (M G / L A S N) | P H (U N I T S) | S P E C I F I C - C O N D U C T I V I T Y (M I C R O - M H O S / C M) | R E D O X - C O N D I T I O N S ^{1/} | H A R D - N E S S (M G / L A S C A C O ₃) | T E M P E R A T U R E ^{2/} (C E L S I U S) |
|-----------------------------|------------------|---|------------------|---|--|---|--|--|---------------------------------------|--|---|---|---|
| | | | | | | | | | | | | | |
| 1 | NH | CHETCO RIVER | 04/06/82 | <1 | 11 | <3 | 4 | 0.4 | 7.3 | 500 | -- | 53 | -- |
| 2 | EH | CHETCO RIVER | 04/06/82 | 9 | 400 | <10 | 18 | -- | 7.6 | 7200 | 0 | -- | 18.5 |
| 3 | EH | CHETCO RIVER | 04/06/82 | 4 | <100 | <10 | 4 | -- | 7.9 | 8000 | R | -- | 18.0 |
| 4 | EH | CHETCO RIVER | 04/06/82 | 4 | <100 | <10 | 6 | 5.4 | 8.2 | 10200 | R | 860 | 13.0 |

1/ THE LETTER ASSIGNED UNDER REDOX (REDUCING/OXIDIZING) CONDITIONS INDICATES THE OXYGEN CONDITIONS PREVALENT DURING THE 60 MINUTE QUIESCENT PERIOD FOLLOWING MIXING OF THE ELUTRIATE SAMPLE AND PRECEDING FILTRATION AND PRESERVATION;
O = OXIDIZING CONDITIONS, AND R = REDUCING CONDITIONS.

2/ AVERAGE TEMPERATURE VALUES DURING ELUTRIATION TESTS.

TABLE 4d.---CHETCO RIVER, OREGON PROJECT

DISSOLVED ORGANOCHLORINE AND CHLOROPHENOXY COMPOUNDS IN NATIVE WATER AND ELUTRIATES

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| SITE NO. | SITE DESCRIPTION | DATE | ALDRIN (UG/L) | CHLOR-DANE (UG/L) | DDD (UG/L) | DDE (UG/L) | DDT (UG/L) | DI-ELDRIN (UG/L) | ENDO-SULFAN (UG/L) | ENDRIN (UG/L) | HEPTA-CHLOR (UG/L) | LINDANE (UG/L) | MIREX (UG/L) |
|----------|------------------|----------|---------------|-------------------|------------|------------|------------|------------------|--------------------|---------------|--------------------|----------------|--------------|
| | | | | | | | | | | | | | |
| 1 | CHETCO RIVER NH | 04/06/82 | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 2 | CHETCO RIVER EH | 04/06/82 | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 3 | CHETCO RIVER EH | 04/06/82 | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 4 | CHETCO RIVER EH | 04/06/82 | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 1 | CHETCO RIVER NH | | <0.1 | <0.1 | <0.1 | <0.1 | <0.01 | <0.01 | <1 | <0.01 | <0.01 | <0.01 | <0.01 |
| 2 | CHETCO RIVER EH | | <0.1 | <0.1 | <0.1 | <0.1 | <0.01 | <0.01 | <1 | <0.01 | <0.01 | <0.01 | <0.01 |
| 3 | CHETCO RIVER EH | | <0.1 | <0.1 | <0.1 | <0.1 | <0.01 | <0.01 | <1 | <0.01 | <0.01 | <0.01 | <0.01 |
| 4 | CHETCO RIVER EH | | <0.1 | <0.1 | <0.1 | <0.1 | -- | -- | <1 | -- | -- | -- | -- |

TABLE 4e.--CHETCO RIVER, OREGON PROJECT

RESULTS OF GAS CHROMATOGRAPHY/MASS SPECTROMETRY FOR ACID/NEUTRAL EXTRACTABLE DISSOLVED ORGANICS DETECTED IN NATIVE WATER AND ELUTRIATES

[SPECTRUM MATCHES OBTAINED FROM NATIONAL BUREAU OF STANDARDS COMPUTERIZED LIBRARY, MATCH FACTORS LESS THAN .9 ARE SHOWN IN PARENTHESES FOLLOWING THE CONCENTRATIONS, THE QUALITY OF THE MATCH BETWEEN SAMPLE AND SPECTRA INCREASE AS THE LIBRARY MATCH FACTOR APPROACHES 1.00, OTHER COMPOUNDS WERE OBSERVED IN DETECTABLE CONCENTRATIONS BUT WERE NOT IDENTIFIED BY THE LIBRARY SEARCH. FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE FRESH WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL, VALUES = '--' INDICATE THAT CONSTITUENT WAS NOT DETECTED IN THE SCAN.]

| S I T E | C O D E | SITE DESCRIPTION | DATE | BENZENETHANOL (UG/L) | BENZOTHIAZOLE (UG/L) | 1,2,BENZISOTHIAZOLE (UG/L) | PHENOL (UG/L) | SULFUR, 1/ MOLECULAR S8 (UG/L) |
|------------------|------------------|---------------------|----------|-------------------------|-------------------------|-------------------------------|------------------|--|
| 1 | NH | CHETCO RIVER | 04/06/82 | -- | -- | 0.4 (.83) | -- | -- |
| 2 | EH | CHETCO RIVER | 04/06/82 | 1.8 | -- | 1 (.64) | -- | 0.6 (.85) |
| 3 | EH | CHETCO RIVER | 04/06/82 | -- | -- | -- | 0.4 (.78) | 0.4 (.85) |
| 4 | EH | CHETCO RIVER | 04/06/82 | 0.6 | 0.3 (.86) | -- | -- | 0.3 (.84) |

1/ AN ELEMENTAL FORM OF SULFUR OCCURRING IN 8-MEMBERED, PUCKERED RINGS OF SULFUR ATOMS.

TABLE 4f.--CHETCO RIVER, OREGON PROJECT

TOTAL RECOVERABLE CHEMICALS IN BOTTOM MATERIAL

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| SITE NO. | SITE DESCRIPTION | DATE | ARSENIC | | CADMIUM | CHROMIUM | | COPPER | IRON | LEAD | MANGANESE | | MERCURY | ZINC |
|----------|------------------|----------|---------|--------|---------|----------|--------|--------|------|------|-----------|--------|---------|------|
| | | | (UG/G) | (UG/G) | | (UG/G) | (UG/G) | | | | (UG/G) | (UG/G) | | |
| 2 | CHETCO RIVER BM | 04/06/82 | 9 | | 3 | 10 | 37 | 9000 | <10 | 300 | 0.14 | 41 | | |
| 4 | CHETCO RIVER BM | 04/06/82 | 8 | | 3 | 30 | 72 | 20000 | 20 | 220 | 0.15 | 85 | | |

TABLE 4g.--CHETCO RIVER, OREGON PROJECT

TOTAL RECOVERABLE ORGANOCHLORINE COMPOUNDS IN BOTTOM MATERIAL

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| S I T E N O. | C O D E | S I T E D E S C R I P T I O N | D A T E | ALDRIN | | CHLOR- DANE | | DDD | | DDE | | DDT | | DI- ELDRIN | | ENDO- SULFAN | | HEPTA- CHLOR | | HEPTA- CHLOR EPOXIDE | |
|-----------------------------|------------------|---|------------------|---------|---------|----------------|---------|---------|---------|---------|---------|---------|---------|---------------|---------|-----------------|---------|-----------------|---------|----------------------------|---------|
| | | | | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) | (UG/KG) |
| 2 | BM | CHETCO RIVER | 04/06/82 | <0.1 | <0.1 | <1 | <0.1 | <0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | |
| 4 | BM | CHETCO RIVER | 04/06/82 | <0.1 | <0.1 | 2 | 0.1 | 0.1 | <0.1 | <0.1 | 0.1 | 0.1 | <0.1 | 0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.1 | |

TABLE 4g.--CHETCO RIVER, OREGON PROJECT
 TOTAL RECOVERABLE ORGANOCHLORINE COMPOUNDS IN BOTTOM MATERIAL--CONTINUED

| S I T E NO. | SITE DESCRIPTION | METH- OXY- CHLOR (UG/KG) | MIREX (UG/KG) | PCB (UG/KG) | PCN (UG/KG) | PER- THANE (UG/KG) | TOXA- PHENE (UG/KG) |
|-------------------------|---------------------|-----------------------------------|------------------|----------------|----------------|--------------------------|---------------------------|
| | | | | | | | |
| 2 | CHETCO RIVER BM | <0.1 | <0.1 | 1 | <1 | <1 | <10 |
| 4 | CHETCO RIVER BM | 1.5 | <0.1 | 5 | <1 | <1 | <10 |

TABLE 4h.--CHETCO RIVER, OREGON PROJECT

RESULTS OF GAS CHROMATOGRAPHY/MASS SPECTROMETRY FOR ACID/NEUTRAL EXTRACTABLE ORGANIC CONSTITUENTS DETECTED IN BOTTOM MATERIAL

[SPECTRUM MATCHES OBTAINED FROM NATIONAL BUREAU OF STANDARDS COMPUTERIZED LIBRARY, MATCH FACTORS LESS THAN .9 ARE SHOWN IN PARENTHESES FOLLOWING THE CONCENTRATIONS, THE QUALITY OF THE MATCH BETWEEN SAMPLE AND SPECTRA INCREASE AS THE LIBRARY MATCH FACTOR APPROACHES 1.00, OTHER COMPOUNDS WERE OBSERVED IN DETECTABLE CONCENTRATIONS BUT WERE NOT IDENTIFIED BY THE LIBRARY SEARCH. FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE FRESH WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL, VALUES = '---' INDICATE THAT CONSTITUENT WAS NOT DETECTED IN THE SCAN.]

| S I T E NO. | C O D E | S I T E DESCRIPTION | DATE | BENZENE, 1-ETHYL, 3-METHYL (MG/KG) | 5-HEXENE-, 2-ONE (MG/KG) | NAPHTHALENE, 1,4-DIMETHYL (MG/KG) | PENTADECANOIC ACID, METHYL ESTER (MG/KG) | SULFUR MOLECULAR S8 (MG/KG) | TETRADECANOIC ACID, METHYL ESTER (MG/KG) | 1,2,4-TRITHIOLANE (MG/KG) |
|-------------|---------|---------------------|----------|------------------------------------|--------------------------|-----------------------------------|--|-----------------------------|--|---------------------------|
| 2 | BM | CHETCO RIVER | 04/07/82 | 0.1 (.76) | 1.2 (.67) | --- | 0.1 | --- | 0.1 (.89) | --- |
| 4 | BM | CHETCO RIVER | 04/07/82 | --- | --- | 0.4 | --- | 2.5 | --- | 0.6 (.67) |

TABLE 4i.--CHETCO RIVER, OREGON PROJECT

PARTICLE-SIZE DISTRIBUTION OF BOTTOM MATERIAL

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| S I T E NO. | C O D E | S I T E D E S C R I P T I O N | D A T E | P A R T I C L E - S I Z E D I S T R I B U T I O N | | | | | | |
|-------------------------|------------------|---|------------------|---|--|--|--|--|--|--|
| | | | | P E R C E N T F I N E R T H A N .062 M M | P E R C E N T F I N E R T H A N .125 M M | P E R C E N T F I N E R T H A N .250 M M | P E R C E N T F I N E R T H A N .500 M M | P E R C E N T F I N E R T H A N 1.00 M M | P E R C E N T F I N E R T H A N 2.00 M M | P E R C E N T F I N E R T H A N 4.00 M M |
| 2 | BM | CHETCO RIVER | 04/06/82 | 89 | 97 | 99 | 99 | 99 | 99 | 100 |
| 3 | BM | CHETCO RIVER | 04/06/82 | 97 | 98 | 99 | 99 | 99 | 99 | 100 |
| 4 | BM | CHETCO RIVER | 04/06/82 | 38 | 70 | 94 | 99 | 99 | 99 | 100 |

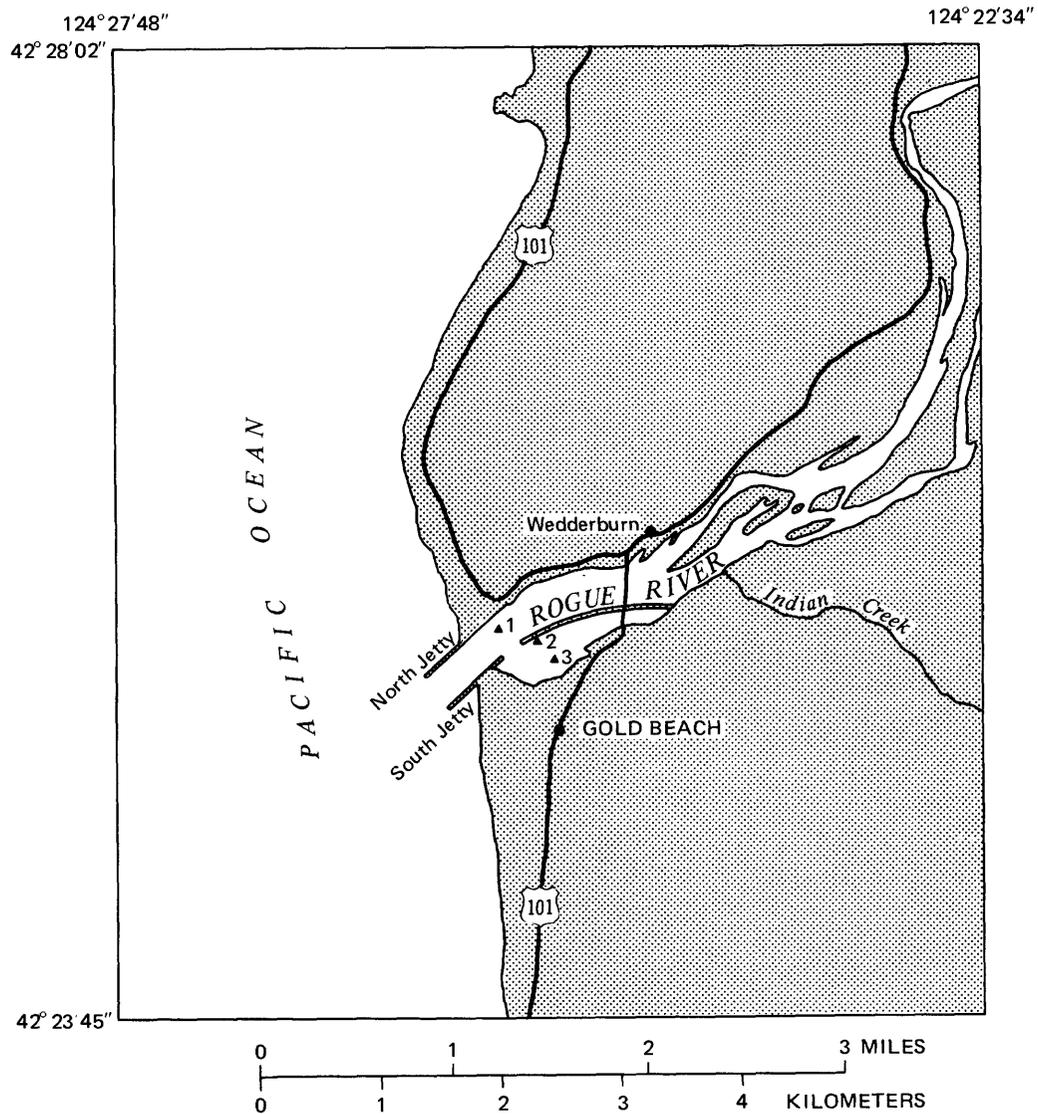


Figure 6.—Sampling sites for the Rogue River, Oregon.

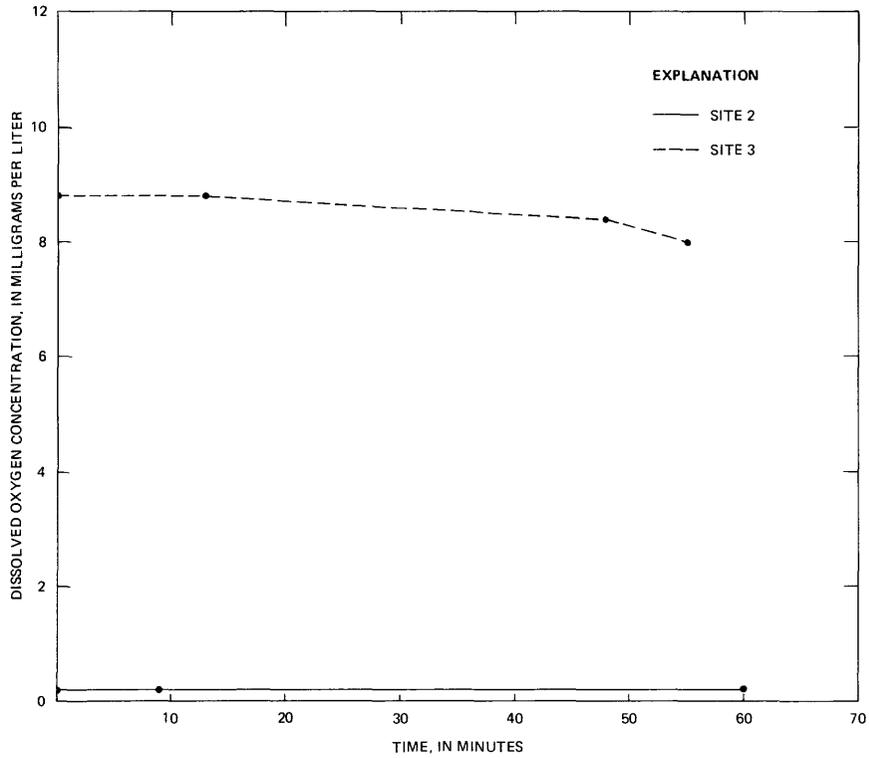


Figure 7.—Dissolved oxygen concentration versus time for Rogue River elutriate samples following the 30 minute mixing period. (Dissolved oxygen concentration at 100 percent saturation is 10.3 mg/L at site 2 and 10.0 mg/L at site 3.)

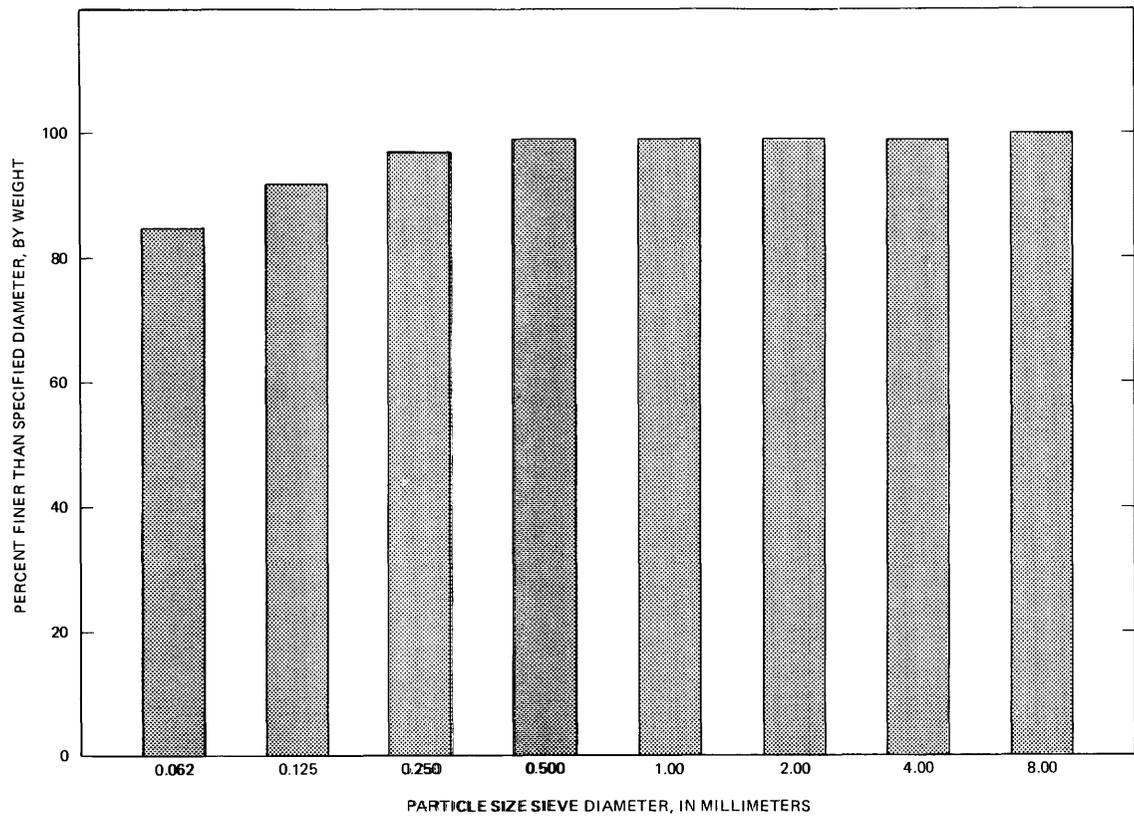


Figure 8.—Particle size distribution of bottom material from Rogue River sampling site 2.

Table 5a.---Location of sampling sites, Rogue River, Oreg., project

| Site no. | Site designation | Collection date | Site location | | Remarks |
|----------|------------------|-----------------|---------------|------------|--|
| | | | Latitude | Longitude | |
| 1 | Rogue River | 04-07-82 | 42°25'28" | 124°25'28" | Water sample collected in stream at mouth of channel connected to turning basin (RM 0.3). Midway in channel connected to turning basin. 50 yards inside turning basin. |
| 2 | do. | do. | 42°25'24" | 124°25'18" | |
| 3 | do. | do. | 42°25'21" | 124°25'08" | |

TABLE 5b.--ROGUE RIVER, OREGON PROJECT
DISSOLVED CHEMICALS IN NATIVE WATER AND ELUTRIATES

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| S I T E N O. | C O D E | S I T E D E S C R I P T I O N | D A T E | C A D M I U M ^{1/} (U G / L A S C D) | C H R O M I U M (U G / L A S C R) | C O P P E R (U G / L A S C U) | I R O N (U G / L A S F E) | L E A D (U G / L A S P B) | M A N G A N E S E (U G / L A S M N) | M E R C U R Y (U G / L A S H G) | Z I N C (U G / L A S Z N) | C A R B O N, O R G A N I C (M G / L A S C) | N I T R O G E N, A M M O N I A (M G / L A S N) |
|-----------------------------|------------------|---|------------------|--|--|--|--|--|---|---|--|---|---|
| | | | | | | | | | | | | | |
| 1 | NF | ROGUE RIVER | 04/07/82 | <3 | 2 | 2 | 78 | <1 | <10 | <0.1 | 12 | 1.7 | <0.06 |
| 2 | EH | ROGUE RIVER | 04/07/82 | <3 | 5 | 4 | 840 | <1 | 230 | <0.1 | 61 | 13.0 | 1.70 |
| 3 | EF | ROGUE RIVER | 04/07/82 | <3 | 2 | 9 | 580 | 3 | 91 | 0.1 | 19 | -- | 0.30 |

^{1/} CADMIUM ANALYSIS HAS A DETECTION LIMIT OF 3 UG/L.

TABLE 5c.--ROGUE RIVER, OREGON PROJECT

ADDITIONAL DISSOLVED CHEMICALS IN NATIVE WATER AND ELUTRIATES

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EF=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '--' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| S I T E | C O D E | D A T E | A R S E N I C | B A R I U M | B E R Y L L I U M | N I C K E L | N I T R O G E N , A M M O N I A + O R G A N I C | P H | S P E C I F I C C O N D U C T A N C E | R E D O X C O N D I T I O N S | H A R D N E S S | T E M P E R A T U R E |
|---------|----------------|----------|---------------|--------------|-------------------|--------------|---|---------|---------------------------------------|-------------------------------|------------------------------|-----------------------|
| NO. | DESCRIPTION | | (UG/L AS AS) | (UG/L AS BA) | (UG/L AS BE) | (UG/L AS NI) | (MG/L AS N) | (UNITS) | (MICRO-MHOS/CM) | | (MG/L AS CaCO ₃) | (CELSIUS) |
| 1 | ROGUE RIVER NF | 04/07/82 | <1 | <100 | <3 | 5 | 0.5 | 7.4 | 97 | -- | 42 | -- |
| 2 | ROGUE RIVER EH | 04/07/82 | 15 | <100 | <3 | 14 | 3.1 | 8.0 | 2000 | R | -- | 14.0 |
| 3 | ROGUE RIVER EF | 04/07/82 | -- | -- | -- | -- | -- | 8.1 | 400 | 0 | -- | 16.5 |

1/ THE LETTER ASSIGNED UNDER REDOX (REDUCING/OXIDIZING) CONDITIONS INDICATES THE OXYGEN CONDITIONS PREVALENT DURING THE 60 MINUTE QUIESCENT PERIOD FOLLOWING MIXING OF THE ELUTRIATE SAMPLE AND PRECEDING FILTRATION AND PRESERVATION; 0 = OXIDIZING CONDITIONS, AND R = REDUCING CONDITIONS.

2/ AVERAGE TEMPERATURE VALUES DURING ELUTRIATION TESTS.

TABLE 5d. ---ROGUE RIVER, OREGON PROJECT

DISSOLVED ORGANOCHLORINE AND CHLOROPHENOXY COMPOUNDS IN NATIVE WATER AND ELUTRIATES

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| S I T E N O. | C O D E | S I T E D E S C R I P T I O N | D A T E | A L D R I N (U G / L) | C H L O R - D A N E (U G / L) | D D D (U G / L) | D D E (U G / L) | D D T (U G / L) | D I - E L D R I N (U G / L) | E N D O - S U L F A N (U G / L) | E N D R I N (U G / L) | H E P T A - C H L O R (U G / L) | L I N D A N E (U G / L) | M I R E X (U G / L) |
|-----------------------------|------------------|---|------------------|--|--|---------------------------------------|---------------------------------------|---------------------------------------|---|---|--|---|---|---|
| | | | | | | | | | | | | | | |
| 1 | NF | ROGUE RIVER | 04/07/82 | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 2 | EH | ROGUE RIVER | 04/07/82 | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 3 | EF | ROGUE RIVER | 04/07/82 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

TABLE 5d.--ROGUE RIVER, OREGON PROJECT
 DISSOLVED ORGANOCHLORINE AND CHLOROPHENOXO COMPOUNDS IN NATIVE WATER AND ELUTRIATES--CONTINUED

| S I T E N O. | C O D E | S I T E D E S C R I P T I O N | P C B (U G / L) | N A P H T H A - L E N E S, P O L Y - C H L O R (U G / L) | P E R - T H A N E (U G / L) | S I L V E X (U G / L) | T O X - A P H E N E (U G / L) | 2,4-D (U G / L) | 2,4-DP (U G / L) | 2,4,5-T (U G / L) |
|-----------------------------|------------------|---|---------------------------------------|--|---|--|--|---------------------------------|----------------------------------|-----------------------------------|
| | | | | | | | | | | |
| 1 | ROGUE RIVER NF | | <0.1 | <0.1 | <0.1 | <0.01 | <1 | <0.01 | 0.01 | <0.01 |
| 2 | ROGUE RIVER EH | | <0.1 | <0.1 | <0.1 | <0.01 | <1 | <0.01 | 0.01 | <0.01 |
| 3 | ROGUE RIVER EF | | -- | -- | -- | -- | -- | -- | -- | -- |

TABLE 5e.--ROGUE RIVER, OREGON PROJECT

RESULTS OF GAS CHROMATOGRAPHY/MASS SPECTROMETRY FOR ACID/NEUTRAL EXTRACTABLE DISSOLVED ORGANICS DETECTED IN NATIVE WATER AND ELUTRIATES

[SPECTRUM MATCHES OBTAINED FROM NATIONAL BUREAU OF STANDARDS COMPUTERIZED LIBRARY, MATCH FACTORS LESS THAN .9 ARE SHOWN IN PARENTHESES FOLLOWING THE CONCENTRATIONS, THE QUALITY OF THE MATCH BETWEEN SAMPLE AND SPECTRA INCREASE AS THE LIBRARY MATCH FACTOR APPROACHES 1.00, OTHER COMPOUNDS WERE OBSERVED IN DETECTABLE CONCENTRATIONS BUT WERE NOT IDENTIFIED BY THE LIBRARY SEARCH. FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL, VALUES = '---' INDICATE THAT CONSTITUENT WAS NOT DETECTED IN THE SCAN.]

| S I T E NO. | C O D E | DESCRIPTION | DATE | BENZOIC ACID | BENZOIC ACID | BENZOIC ACID | BENZOISO- | PHENOL | SULFUR ^{1/} |
|-------------------------|------------------|-------------|-----------|------------------------|---------------------|--------------------|------------|---------------------------|----------------------|
| | | | | 3,4-DICHLORO (UG/L) | 2-HYDROXY (UG/L) | THIAZOLE (UG/L) | (UG/L) | MOLECULAR S8 (UG/L) | |
| 1 | ROGUE RIVER NF | 04/07/82 | 1.6 (.83) | 2.9 | 0.4 (.81) | -- | -- | -- | |
| 2 | ROGUE RIVER EH | 04/07/82 | 2.9 (.60) | -- | -- | 1.5 | 18.5 (.85) | | |

1/ AN ELEMENTAL FORM OF SULFUR OCCURRING IN 8-MEMBERED, PUCKERED RINGS OF SULFUR ATOMS.

TABLE 5f.--ROGUE RIVER, OREGON PROJECT

TOTAL RECOVERABLE CHEMICALS IN BOTTOM MATERIAL

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| S I T E NO. | C O D E | SITE DESCRIPTION | DATE | ARSENIC | | CADMIUM | | CHRO- MIUM | | COPPER | | IRON | | LEAD | | MANGA- NESE | | MERCURY | | ZINC | |
|-------------------------|------------------|---------------------|----------|---------|--------|---------|--------|---------------|--------|--------|--------|--------|--------|--------|--------|----------------|--------|---------|--------|--------|--------|
| | | | | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) | (UG/G) |
| 2 | BM | ROGUE RIVER | 04/07/82 | 6 | 1 | 20 | 20 | 3100 | 10 | 230 | 0.10 | 13 | | | | | | | | | |

TABLE 5g.---ROGUE RIVER, OREGON PROJECT

TOTAL RECOVERABLE CHLOROPHENOXY COMPOUNDS IN BOTTOM MATERIAL

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| S I T E N O. | C O D E | DATE | ALDRIN (UG/KG) | CHLOR- DANE (UG/KG) | DDD (UG/KG) | DDE (UG/KG) | DDT (UG/KG) | DI- ELDRIN (UG/KG) | ENDO- SULFAN (UG/KG) | ENDRIN (UG/KG) | HEPTA- CHLOR (UG/KG) | HEPTA- CHLOR EPOXIDE (UG/KG) | LINDANE (UG/KG) |
|-----------------------------|-------------------|----------|-------------------|---------------------------|----------------|----------------|----------------|--------------------------|----------------------------|-------------------|----------------------------|---------------------------------------|--------------------|
| 2 | ROGUE RIVER BM | 04/07/82 | <0.1 | 1 | 1.0 | 2.3 | 1.9 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

TABLE 5g.--ROGUE RIVER, OREGON PROJECT
 TOTAL RECOVERABLE CHLOROPHENOXY COMPOUNDS IN BOTTOM MATERIAL--CONTINUED

| S I T E NO. | C O D E | S I T E D E S C R I P T I O N | METH- OXY- CHLOR (UG/KG) | MIREX (UG/KG) | PCB (UG/KG) | PCN (UG/KG) | PER- THANE (UG/KG) | TOXA- PHENE (UG/KG) |
|-------------------------|------------------|---|-----------------------------------|------------------|----------------|----------------|--------------------------|---------------------------|
| | | | | | | | | |
| 2 | BM | ROGUE RIVER | 0.7 | <0.1 | 2 | <1 | 1 | <10 |

TABLE 5h.--ROGUE RIVER, OREGON PROJECT

RESULTS OF GAS CHROMATOGRAPHY/MASS SPECTROMETRY FOR ACID/NEUTRAL EXTRACTABLE ORGANIC CONSTITUENTS DETECTED IN BOTTOM MATERIAL

[SPECTRUM MATCHES OBTAINED FROM NATIONAL BUREAU OF STANDARDS COMPUTERIZED LIBRARY, MATCH FACTORS LESS THAN .9 ARE SHOWN IN PARENTHESES FOLLOWING THE CONCENTRATIONS, THE QUALITY OF THE MATCH BETWEEN SAMPLE AND SPECTRA INCREASE AS THE LIBRARY MATCH FACTOR APPROACHES 1.00, OTHER COMPOUNDS WERE OBSERVED IN DETECTABLE CONCENTRATIONS BUT WERE NOT IDENTIFIED BY THE LIBRARY SEARCH. FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE FRESH WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL, VALUES = '---' INDICATE THAT CONSTITUENT WAS NOT DETECTED IN THE SCAN.]

| S I T E NO. | C O D E | DATE | 1, <u>1</u> / 2,4-TRITHIOLANE (MG/KG) | HEXADECANDOC ACID, METHYL ESTER (MG/KG) | SULFUR ^{2/} MOLECULAR S8 (MG/KG) |
|-------------------------|------------------|----------|---|---|--|
| 2 | ROGUE RIVER BM | 04/07/82 | 7.1 | 21 | 4.4 |

1/ HS-SH-CH₂-SH-CH₂.

2/ AN ELEMENTAL FORM OF SULFUR OCCURRING IN 8-MEMBERED, PUCKERED RINGS OF SULFUR ATOMS.

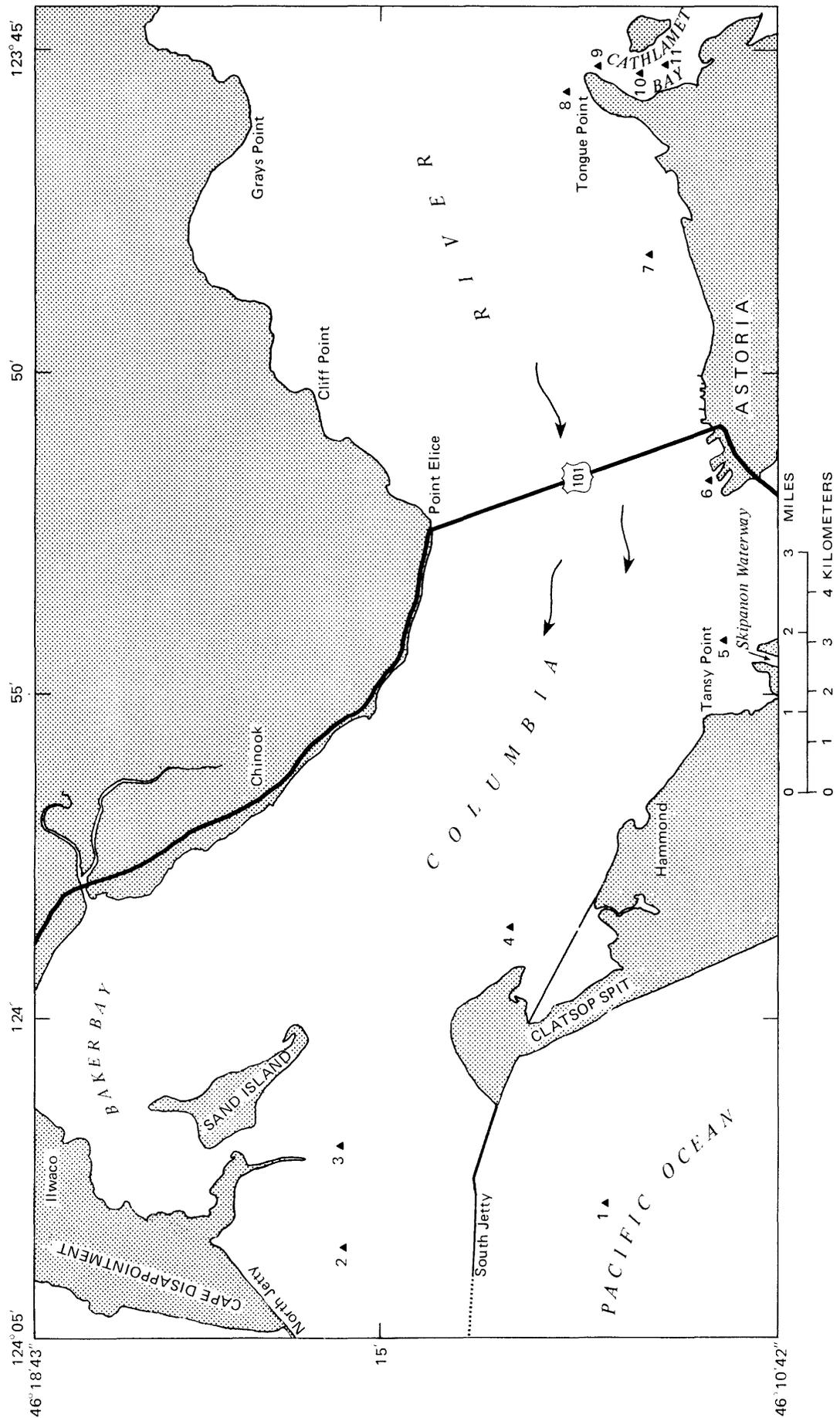


Figure 9.- Sampling sites for the Columbia River.

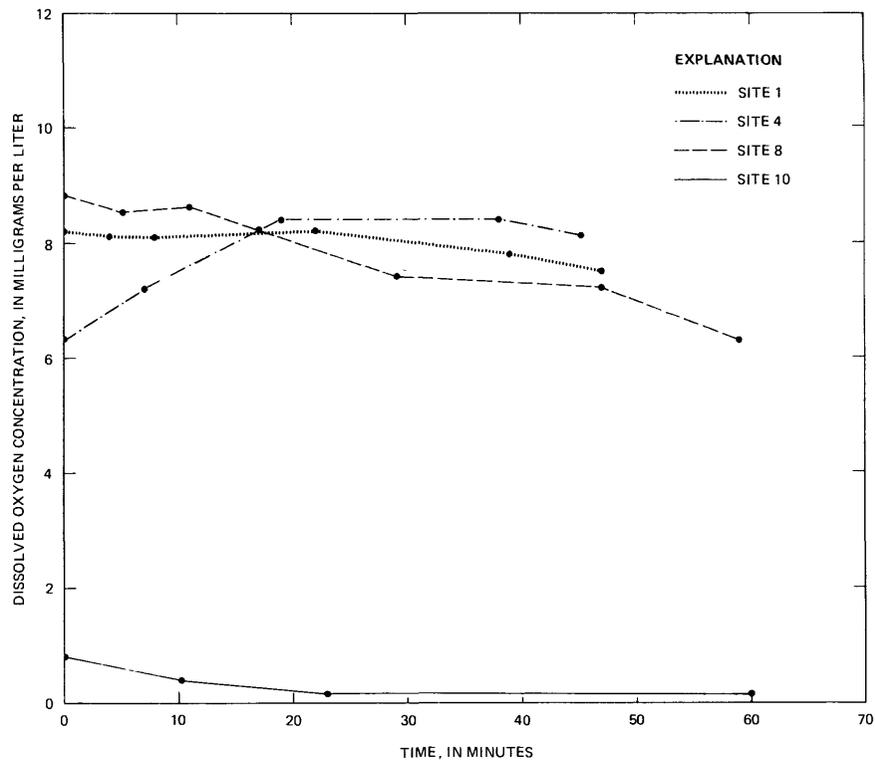


Figure 10.—Dissolved oxygen concentration versus time for Columbia River elutriate samples following the 30 minute mixing period. (Dissolved oxygen concentration at 100 percent saturation is 8.2 mg/L at site 1, 9.0 mg/L at site 4, 8.8 mg/L at site 8, and 8.3 mg/L at stie site 10.)

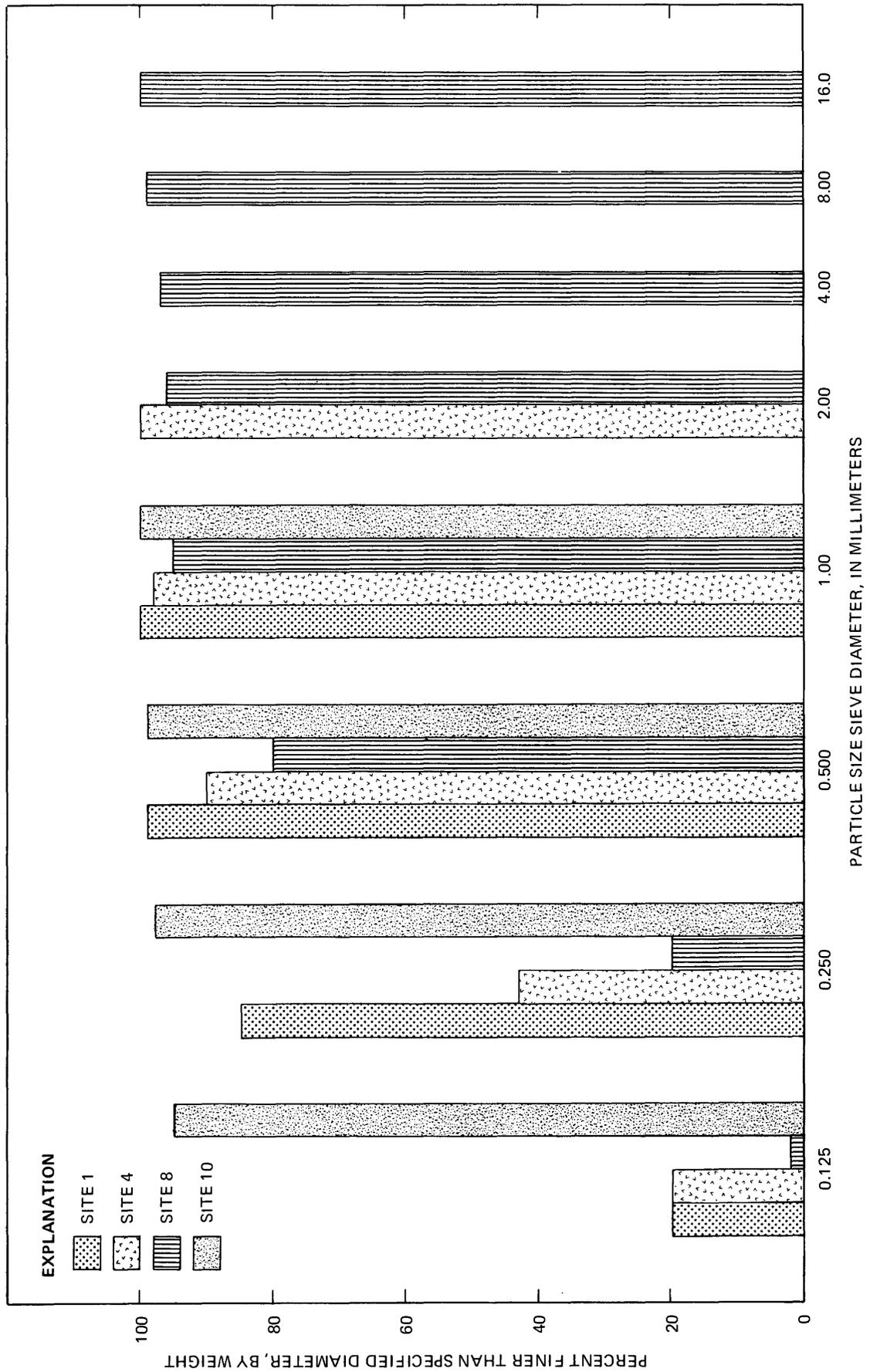


Figure 11.--Particle size distribution of bottom material from Columbia River sampling sites 1, 4, 8, and 10.

Table 6a.--Location of sampling sites, Columbia River, Oreg., project

| Site no. | Site designation | Collection date | Site location | | Remarks |
|----------|------------------|-----------------|---------------|--------------|----------------------------|
| | | | Latitude | Longitude | |
| 1 | Pacific Ocean | 08-03-82 | 46° 11' 27" | 124° 02' 48" | Water and sediment sample. |
| 2 | Columbia River | do. | 46° 15' 30" | 124° 03' 32" | RM 1.8. |
| 3 | do. | do. | 46° 15' 20" | 124° 01' 45" | RM 3.2. |
| 4 | do. | do. | 46° 13' 33" | 123° 58' 15" | RM 6.6. |
| 5 | do. | do. | 46° 11' 32" | 123° 54' 08" | RM 11. |
| 6 | do. | 08-02-82 | 46° 11' 30" | 123° 51' 39" | RM 13. |
| 7 | do. | do. | 46° 12' 15" | 123° 48' 08" | RM 16. |
| 8 | do. | do. | 46° 13' 05" | 123° 45' 50" | RM 18.1. |
| 9 | Cathlamet Bay | do. | 46° 12' 34" | 123° 45' 15" | |
| 10 | do. | do. | 46° 12' 14" | 123° 45' 21" | Near pier 6. |
| 11 | do. | do. | 46° 11' 53" | 123° 45' 09" | |

TABLE 6b.--COLUMBIA RIVER, OREGON PROJECT
DISSOLVED CHEMICALS IN NATIVE WATER AND ELUTRIATES

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| SITE | NO. | DESCRIPTION | DATE | CADMIUM (UG/L AS CD) | CHROMIUM (UG/L AS CR) | COPPER (UG/L AS CU) | IRON (UG/L AS FE) | LEAD (UG/L AS PB) | MANGANESE (UG/L AS MN) | MERCURY (UG/L AS HG) | ZINC (UG/L AS ZN) | CARBON, ORGANIC (MG/L AS C) | NITROGEN, AMMONIA (MG/L AS N) | TOTAL ^{1/} |
|------|-----|------------------|-------------|----------------------------|-----------------------------|---------------------------|-------------------------|-------------------------|------------------------------|----------------------------|-------------------------|--------------------------------------|--|---------------------|
| | | | | | | | | | | | | | | PHENOLS (UG/L) |
| | 1 | PACIFIC OCEAN | NE 08/02/82 | <1 | <1 | <1 | 200 | <1 | 40 | <0.1 | 30 | 2.2 | 0.08 | <1 |
| | 1 | PACIFIC OCEAN | EE 08/03/82 | 210 | <1 | 1 | 200 | <1 | 40 | <0.1 | 30 | 3.4 | 0.17 | 1 |
| | 4 | COLUMBIA RM 6.6 | EE 08/03/82 | 1 | <1 | <1 | 170 | <1 | 630 | <0.1 | 40 | 2.8 | 0.59 | 260 |
| | 8 | COLUMBIA RM 18.1 | EE 08/02/82 | 2 | <1 | 2 | 160 | <1 | 240 | <0.1 | 40 | 2.0 | 0.09 | 26 |
| | 10 | CATHLAMET BAY | EE 08/02/82 | 7 | <1 | 13 | 350 | <1 | 15000 | <0.1 | 40 | 5.5 | 7.00 | 26 |

1/ TOTAL PHENOLS ANALYSIS WAS MADE BY THE COLORIMETRIC 4-AMINO ANTIPIRYNE METHOD (WERSHAW AND OTHERS, 1983).

TABLE 6c.--COLUMBIA RIVER, OREGON PROJECT
 ADDITIONAL DISSOLVED CHEMICALS IN NATIVE WATER AND ELutriATES

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELutriATE WITH ESTUARINE WATER, EH=ELutriATE WITH EURYHALINE WATER, EF=ELutriATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| NO. | DESCRIPTION | C | D | E | DATE | ARSENIC (UG/L AS AS) | BARIUM (UG/L AS BA) | BERYL- LIUM (UG/L AS BE) | NICKEL (UG/L AS NI) | NITRO- GEN,AM- MONIA + ORGANIC (MG/L AS N) | PH (UNITS) | SPE- CIFIC- CON- DUCT- ANCE (MICRO- MHOS/CM) | REDOX ^{1/} CONDITIONS | TEMPERATURE ^{2/} (CELSIUS) |
|-----|------------------|----|---|---|----------|----------------------------|---------------------------|-----------------------------------|---------------------------|---|---------------|--|-----------------------------------|--|
| 1 | PACIFIC OCEAN | NE | | | 08/02/82 | 1 | <100 | <10 | <1 | 0.5 | 8.1 | 44400 | -- | -- |
| 1 | PACIFIC OCEAN | EE | | | 08/03/82 | 1 | <100 | <10 | 8 | 1.1 | 7.9 | 48000 | 0 | 17.5 |
| 4 | COLUMBIA RM 6.6 | EE | | | 08/03/82 | 1 | <100 | <10 | 3 | 1.4 | 7.8 | 42100 | 0 | 12.5 |
| 8 | COLUMBIA RM 18.1 | EE | | | 08/02/82 | <1 | <100 | <10 | 16 | 0.9 | 7.6 | 35100 | 0 | 13.5 |
| 10 | CATHLAMET BAY | EE | | | 08/02/82 | 1 | <100 | <10 | 2 | 6.4 | 6.7 | 37900 | R | 15.2 |

1/ THE LETTER ASSIGNED UNDER REDOX (REDUCING/OXIDIZING) CONDITIONS INDICATES THE OXYGEN CONDITIONS PREVALENT DURING THE 60 MINUTE QUIESCENT PERIOD FOLLOWING MIXING OF THE ELutriATE SAMPLE AND PRECEDING FILTRATION AND PRESERVATION;
 O = OXIDIZING CONDITIONS, AND R = REDUCING CONDITIONS.

2/ AVERAGE TEMPERATURE VALUES DURING ELutriATION TESTS.

TABLE 6d.--COLUMBIA RIVER, OREGON PROJECT

RESULTS OF GAS CHROMATOGRAPHY/MASS SPECTROGRAPHY FOR ACID/NEUTRAL EXTRACTABLE DISSOLVED ORGANICS DETECTED IN NATIVE WATER AND ELUTRIATES

[SPECTRUM MATCHES OBTAINED FROM NATIONAL BUREAU OF STANDARDS COMPUTERIZED LIBRARY, MATCH FACTORS LESS THAN .9 ARE SHOWN IN PARENTHESES FOLLOWING THE CONCENTRATIONS. THE QUALITY OF THE MATCH BETWEEN SAMPLE AND SPECTRA INCREASE AS THE LIBRARY MATCH FACTOR APPROACHES 1.00, OTHER COMPOUNDS WERE OBSERVED IN DETECTABLE CONCENTRATIONS BUT WERE NOT IDENTIFIED BY THE LIBRARY SEARCH. FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL, VALUES = '---' INDICATE THAT CONSTITUENT WAS NOT DETECTED IN THE SCAN.]

| S I T E NO. | DESCRIPTION | DATE | ANISOLE (UG/L) | BENZENE ACETIC ACID METHYL ESTER (UG/L) | BENZOIC ACID 2-HYDROXY, METHYL ESTER (UG/L) | BENZOIC ACID 3,4-DI CHLORO, METHYL ESTER (UG/L) | BENZENE ETHANOL (UG/L) | BENZENE METHANOL (UG/L) | DIBENZ[A,H] ANTHRACENE (UG/L) | HEXANOIC ACID, METHYL ESTER (UG/L) | HEXANOIC ACID, 2-ETHYL, METHYL ESTER (UG/L) | PHENOL (UG/L) |
|-------------|------------------|-------------|----------------|---|---|---|------------------------|-------------------------|-------------------------------|------------------------------------|---|---------------|
| 1 | PACIFIC OCEAN | NE 08/02/82 | -- | -- | -- | 2.4 | -- | -- | 1.5 (.83) | -- | -- | -- |
| 1 | PACIFIC OCEAN | EE 08/03/82 | -- | -- | -- | -- | -- | -- | -- | -- | 0.9 (.74) | -- |
| 4 | COLUMBIA RM 6-6 | EE 08/03/82 | -- | -- | 6.7 | -- | -- | 3.7 | -- | -- | 3.5 | 37.3 |
| 8 | COLUMBIA RM 18-1 | EE 08/02/82 | -- | 16.7 | 5.1 | -- | 6 | 2.9 (.77) | -- | 4 | 7.8 | 22.2 |
| 10 | CATHLAMET BAY | EE 08/02/82 | 11.1 | -- | 3.3 (.76) | -- | 1.9 | -- | -- | -- | 3.4 | 19.1 |

TABLE 6e.--COLUMBIA RIVER, OREGON PROJECT

TOTAL RECOVERABLE CHEMICALS IN BOTTOM MATERIAL

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| S I T E N O. | C O D E | SITE DESCRIPTION | DATE | ARSENIC (UG/G) | CADMIUM (UG/G) | CHRO- MIUM (UG/G) | COPPER (UG/G) | IRON (UG/G) | LEAD (UG/G) | MANGA- NESE (UG/G) | MERCURY (UG/G) | ZINC (UG/G) |
|-----------------------------|------------------|---------------------|----------|-------------------|-------------------|-------------------------|------------------|----------------|----------------|--------------------------|-------------------|----------------|
| | | | | | | | | | | | | |
| 1 | BM | PACIFIC OCEAN | 08/03/82 | 3 | 10 | 1 | 1 | 1800 | <100 | 40 | 0.01 | 8 |
| 2 | BM | COLUMBIA RM 1.8 | 08/03/82 | 2 | <10 | -- | -- | 3400 | -- | 60 | -- | -- |
| 3 | BM | COLUMBIA RM 3.2 | 08/03/82 | 5 | <10 | -- | -- | 3600 | -- | 90 | -- | -- |
| 4 | BM | COLUMBIA RM 6.6 | 08/03/82 | 2 | <10 | 2 | 2 | 4100 | <100 | 55 | <0.01 | 15 |
| 5 | BM | COLUMBIA RM 11 | 08/03/82 | 2 | <10 | -- | -- | 4800 | -- | 65 | -- | -- |
| 6 | BM | COLUMBIA RM 13 | 08/02/82 | 4 | <10 | -- | -- | 4300 | -- | 65 | -- | -- |
| 7 | BM | COLUMBIA RM 16 | 08/02/82 | 4 | <10 | -- | -- | 3500 | -- | 80 | -- | -- |
| 8 | BM | COLUMBIA RM 18 | 08/02/82 | 2 | <10 | 2 | 2 | 2600 | <100 | 70 | 0.02 | 22 |
| 9 | BM | CATHLAMET BAY | 08/02/82 | 8 | 10 | -- | -- | 6000 | -- | 350 | -- | -- |
| 10 | BM | CATHLAMET BAY | 08/02/82 | 3 | <10 | 3 | 19 | 4300 | <100 | 160 | 0.06 | 40 |
| 11 | BM | CATHLAMET BAY | 08/02/82 | 3 | <10 | -- | -- | 4600 | -- | 140 | -- | -- |

TABLE 6f.--COLUMBIA RIVER, OREGON PROJECT
 RESULTS OF GAS CHROMATOGRAPHY/MASS SPECTROMETRY FOR ACID/NEUTRAL EXTRACTABLE ORGANIC CONSTITUENTS DETECTED IN BOTTOM MATERIAL

[SPECTRUM MATCHES OBTAINED FROM NATIONAL BUREAU OF STANDARDS COMPUTERIZED LIBRARY, MATCH FACTORS LESS THAN .9 ARE SHOWN IN PARENTHESIS FOLLOWING THE CONCENTRATIONS, THE QUALITY OF THE MATCH BETWEEN SAMPLE AND SPECTRA INCREASE AS THE LIBRARY MATCH FACTOR APPROACHES 1.00, OTHER COMPOUNDS WERE OBSERVED IN DETECTABLE CONCENTRATIONS BUT WERE NOT IDENTIFIED BY THE LIBRARY SEARCH. FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL, VALUES = '---' INDICATE THAT CONSTITUENT WAS NOT DETECTED IN THE SCAN.]

| S I T E NO. | C O D E | S I T E DESCRIPTION | D A T E | S U L F U R 1/ MOLECULAR S ₈ (MG/KG) |
|-------------|---------|---------------------|----------|---|
| 1 | | PACIFIC OCEAN | 08/03/82 | -- |
| 4 | | COLUMBIA RM 6.6 | 08/03/82 | .7 |
| 8 | | COLUMBIA RM 18.1 | 08/03/82 | -- |
| 10 | | CATHLANET BAY | 08/03/82 | 1.8 (.84) |

1/ AN ELEMENTAL FORM OF SULFUR OCCURRING IN 8-MEMBERED, PUCKERED RINGS OF SULFUR ATOMS.

TABLE 6g.--COLUMBIA RIVER, OREGON PROJECT
 PARTICLE-SIZE DISTRIBUTION AND PERCENT MOISTURE OF BOTTOM MATERIAL

[FOR TYPE OF SAMPLE, REFER TO CODES: NE=NATIVE ESTUARINE WATER, NH=NATIVE EURYHALINE WATER, NF=NATIVE FRESH WATER, EE=ELUTRIATE WITH ESTUARINE WATER, EH=ELUTRIATE WITH EURYHALINE WATER, EF=ELUTRIATE WITH FRESH WATER, BM=BOTTOM MATERIAL. VALUES = '---' INDICATE THAT AN ANALYSES HAS NOT BEEN MADE.]

| S I T E N O. | C O D E | D E S C R I P T I O N | D A T E | P E R C E N T F I N E R T H A N | | | | | | | | | | P E R C E N T M O I S T U R E |
|-----------------------------|------------------|---|------------------|--|---------|---------|---------|---------|---------|---------|----------|-----|-----|---|
| | | | | .125 MM | .250 MM | .500 MM | 1.00 MM | 2.00 MM | 4.00 MM | 8.00 MM | 16.00 MM | | | |
| 1 | BM | PACIFIC OCEAN | 08/03/82 | 20 | 85 | 99 | 100 | -- | -- | -- | -- | -- | -- | 20 |
| 2 | BM | COLUMBIA RM 1.8 | 08/03/82 | 3 | 67 | 98 | 100 | -- | -- | -- | -- | -- | -- | 19 |
| 3 | BM | COLUMBIA RM 3.2 | 08/03/82 | -- | 27 | 89 | 99 | 100 | 100 | -- | -- | -- | -- | 24 |
| 4 | BM | COLUMBIA RM 6.6 | 08/03/82 | 20 | 43 | 90 | 98 | 100 | 100 | -- | -- | -- | -- | 25 |
| 5 | BM | COLUMBIA RM 11 | 08/03/82 | 8 | 32 | 97 | 99 | 100 | 100 | -- | -- | -- | -- | 26 |
| 6 | BM | COLUMBIA RM 13 | 08/02/82 | 3 | 90 | 100 | -- | -- | -- | -- | -- | -- | -- | 28 |
| 7 | BM | COLUMBIA RM 16 | 08/02/82 | 2 | 25 | 62 | 87 | 90 | 97 | 97 | 99 | 100 | 100 | 18 |
| 8 | BM | COLUMBIA RM 18 | 08/02/82 | 2 | 20 | 80 | 95 | 96 | 97 | 97 | 99 | 100 | 100 | 23 |
| 9 | BM | CATHLAMET BAY | 08/02/82 | 80 | 97 | 99 | 100 | -- | -- | -- | -- | -- | -- | 39 |
| 10 | BM | CATHLAMET BAY | 08/02/82 | 95 | 98 | 99 | 100 | -- | -- | -- | -- | -- | -- | 35 |
| 11 | BM | CATHLAMET BAY | 08/02/82 | 93 | 98 | 99 | 100 | -- | -- | -- | -- | -- | -- | 33 |

TABLE 6h.--COLUMBIA RIVER, OREGON PROJECT

RELEASE OF METALS ASSOCIATED WITH BOTTOM MATERIAL DURING ELUTRIATION-TEST MIXING (ELUTRIATION-TEST RELEASE), IN PERCENT
 [* = ELUTRIATION-TEST-RELEASE COULD NOT BE COMPUTED SINCE REPORTED LABORATORY VALUES ARE BELOW ANALYTICAL DETECTION LIMITS,
 † = NATIVE-MIXING WATER EXCEEDS ELUTRIATE-TEST FILTRATE IN DISSOLVED IRON]

| SITE NO. | SITE DESCRIPTION | ARSENIC | CADMIUM | COPPER | CHROMIUM | IRON | LEAD | MANGANESE | MERCURY | ZINC |
|----------|------------------|---------|---------|--------|----------|------|------|-----------|---------|------|
| 1 | PACIFIC OCEAN | <1 | 1/5 | * | * | <1 | * | <1 | * | <1 |
| 4 | COLUMBIA RM 6.6 | <1 | * | * | * | † | * | 3 | * | <1 |
| 8 | COLUMBIA RM 18 | * | * | 1/ <1 | * | † | * | 1 | * | <1 |
| 10 | CATHLAMET BAY | <1 | * | 1/ <1 | * | <1 | * | 35 | * | <1 |

1/ Elutriation-test release was computed using a minimum and maximum native estuarine water concentration of 0 ug/L and 1 ug/L for Cadmium and Copper since they were reported as <1 ug/L in the native estuarine mixing water (see Table 6b, Site No. 1 - Code NE).