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CHEMICAL EVALUATIONS OF JOHN F. BALDWIN SHIP CHANNEL SEDIMENT

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EXECUTIVE SUMMARY

In October 1989, the Battelle/Marine Sciences Laboratory (MSL) conducted sampling, geological characterization, and chemical evaluation studies on sediment from a proposed ship channel in San Francisco Bay, California. The channel under study was the John F. Baldwin Ship Channel authorized for construction by Congress in 1965. This channel extends from the San Francisco Bar, through San Pablo Bay, into Carquinez Strait, and on to Sacramento. The 1989 study area included a 28-mile-long portion of the John F. Baldwin Ship Channel that extended from West Richmond to and including Carquinez Strait. The objective of our study was to determine physical characteristics and chemical contaminant levels in sediment to the proposed project depth of -45 ft mean lower low water (MLLW) (plus 2 ft of overdepth).

Sediment core samples were collected at 47 locations throughout the John F. Baldwin Ship Channel using a vibratory hammer core sampler. Ten of these locations were from West Richmond, 29 from San Pablo Bay, and 8 from Carquinez Strait. The geological properties of sediment core samples were described, the sediment from the cores was composited into 72 separate samples based on those descriptions, and chemical analyses were conducted of 13 metals, 16 polynuclear aromatic hydrocarbons (PAH), 18 pesticides, 7 PCBs, 3 butyltins, and 4 conventional sediment characteristics. These data were then compared with sediment values from Oakland and Richmond harbors, reference values from Point Reyes fine- and coarse-grained sediments, and from typical shale sediment.

These studies were the first phase of sediment evaluations for this section of the John F. Baldwin Ship Channel. The objective was to inventory sediment contaminants at each location. In general, the sediment from the John F. Baldwin Ship Channel area showed little contamination. However, sediment from the West Richmond area had PAH contamination that was elevated and contained the lower molecular weight PAH compounds that indicate 1) the presence of unweathered petroleum, and 2) the potential for acute toxicity to marine organisms. Sediment from Carquinez Strait and the northeastern end of Pinole Shoal had elevated levels of aluminum, arsenic, and mercury that were not correlated to the concentration of total organic carbon or grain

size. This lack of correlation to other sediment characteristics may indicate that these metals have different availabilities to organisms. The central region of Pinole Shoal (P VI and P VII) appeared to contain elevated levels of one or more metals. This information will be used to plan further evaluations that will be conducted during the next phase of the project.

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1.0 INTRODUCTION

The John F. Baldwin Ship Channel is part of the San Francisco Bay to Stockton, California, Navigation Project authorized by the River and Harbors Act of 1965 (Public Law 89-298). The U.S. Army Corps of Engineers (USACE), San Francisco District, is responsible for constructing the John F. Baldwin Ship Channel, and the Corps' Sacramento District is responsible for constructing the Stockton Deep Water Channel portion of the project. The John F. Baldwin Ship Channel extends from San Francisco Bay near the city of San Francisco through Suisun Bay, and consists of five improvement or construction areas: the San Francisco Bar, West Richmond, Pinole Shoal, Carquinez Strait, and Suisun channels. These improvements were planned to be completed in three phases. Under Phase I, completed in 1974, a 2000-ft-wide channel was built to a depth of -55 ft mean lower low water (MLLW) across the San Francisco Bar near the Golden Gate. Phase II, approved in 1984, provided channel improvements to -45 ft MLLW in central San Francisco Bay near Richmond, California. Phase III plans to improve a 28-mile section of the John F. Baldwin Ship Channel between San Francisco Bay, west of Richmond, and Suisun Bay. This third development phase is the subject of this report.

Planned Phase III channel improvements include deepening the John F. Baldwin Ship Channel to -45 ft MLLW in the West Richmond, Pinole Shoal, and Carquinez Strait reaches, shown in Figure 1.1. Approximately 800,000 yd^3 of sediment will be removed from West Richmond, 7,000,000 yd^3 from Pinole Shoal, and 700,000 yd^3 from Carquinez Strait. The sediment proposed for removal from these project areas is being considered for use in creating wetlands or marshes, in-bay disposal at Alcatraz Island, or offshore disposal. Before selecting one of these alternatives, the USACE is required to test the sediment for chemical concentrations, and may later test for biological toxicity. The San Francisco District of the USACE requested the

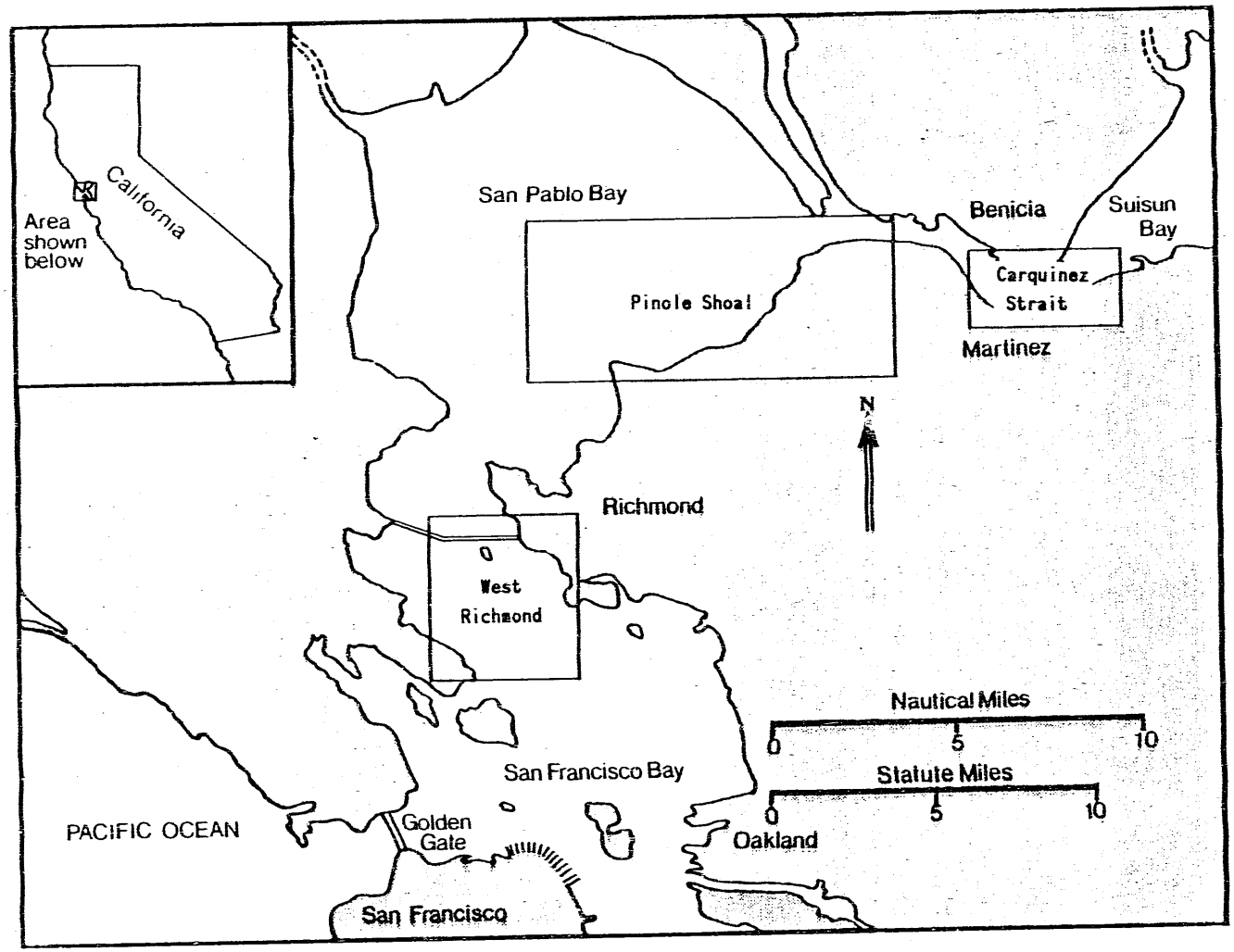


FIGURE 1.1. John F. Baldwin Ship Channel Study Area, Showing West Richmond, Pinole Shoal, and Carquinez Strait Reaches

Battelle/Marine Sciences Laboratory (MSL)[a] in Sequim, Washington, to participate in the design and implementation of a program to evaluate sediments from the John F. Baldwin Ship Channel Phase III project area.

Battelle/Marine Sciences Laboratory's John F. Baldwin Ship Channel program was designed to provide comprehensive information on the chemical, physical, and geological characteristics of sediments in the project area. Sediment core samples were collected to a depth of -47 ft MLLW from the channel and composited into samples for analysis. Grain size, total organic carbon (TOC), oil and grease, petroleum hydrocarbons, metals, butyltins, semivolatile organic compounds, chlorinated pesticides, and polychlorinated biphenyls were measured in each sample. From this information, USACE can evaluate disposal alternatives or the necessity of conducting a more extensive biological characterization.

This report documents the field sampling, geological analysis of sediment cores, sample preparation (compositing), chemical analysis, and quality control elements of the program. Methods for these components are reported in Section 2.0. In Section 3.0 the results of field sampling, geological analysis, sample preparation, and chemical analyses are summarized and discussed. Conclusions that were drawn after examination of the data are presented in Section 4.0. Program quality assurance is documented in Section 5.0, and references are listed in Section 6.0. Supporting information and data are contained in Appendices A through D.

(a) The Battelle/Marine Sciences Laboratory is part of the Pacific Northwest Laboratory, which is operated by Battelle Memorial Institute for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830.

2.0 METHODS

2.1 FIELD SAMPLING

The objective of the field sampling program was to collect samples appropriate for determining the horizontal and vertical distribution of geological properties and chemical concentrations in the John F. Baldwin Ship Channel Project area. Specifically, sediment cores were to be collected at 49 sites to a project depth of -45 ft MLLW plus 2 ft of overdepth, or -47 ft MLLW. Planned sampling sites were located in the West Richmond (9 sites), Pinole Shoal (30 sites), and Carquinez Strait (10 sites) reaches of the John F. Baldwin Ship Channel (Figure 1.1).

2.1.1 Navigation

Navigational support was provided by Beak Consultants, Inc. They used two Motorola MiniRanger III consoles with receiver/transceivers and four shore stations to establish location of sampling sites with a horizontal accuracy of ±1 m. This accuracy resulted in a navigational fix within a diameter of ±2 m.

Before sampling, the desired station locations were plotted on charts referenced to California State Plane Coordinates. The preplotted coordinates were used as target points to provide sampling within the 50-ft circle of the desired location. The exact sampling location was selected onsite by using a fathometer to find the minimum water depth within this circle, that is, the location where there was the most sediment to project depth. This resulted in maximum possible length of the sediment core collected in each area.

The procedure to fix sampling locations was to establish three or four navigational shore stations at U.S. Geological Survey (USGS) monuments having published horizontal and vertical control information. The shore stations provided suitable geometry for establishing ranges to each of the sampling sites. After each shore station was identified, transponders were installed and ranges were calculated from each shore station to each of the planned sampling sites. The navigational vessel (a 17-ft Boston Whaler) then proceeded on these ranges to each station and placed a 24-in.-diameter buoy at each site. When the buoy settled into the current and wind, a navigational

fix was taken, and water depth and time were recorded. To calculate the required core length, the water depth was converted to MLLW by applying the appropriate tide correction for each time and location. Corrected water depth, time of sampling, and required core length were recorded on a coring log sheet. If the entire circle was deeper than -47 ft MLLW, the station was either rejected or relocated. The site was then sampled as described in the following section.

2.1.2 Core Sampling

Core sampling was conducted by Manson Construction of Richmond, California, and MSL personnel. Sediment cores were collected with a vibratory hammer coring device (Figure 2.1) operated from the 112- x 52-ft platform of the Manson Construction derrick barge Andrew. The 50-ft long, 4-in.-diameter barrel of the coring device was lined with 3.625-in. diameter polycarbonate Lexan core liner to eliminate cross-contamination between samples and minimize potential contamination of any sample. To prevent contamination before initiation of sampling, all Lexan core liners were steam cleaned and capped, the core barrel was driven into sand to physically polish its inside and outside surfaces, and the barge deck and all portions of the heavy sampling gear were rinsed with seawater. Depending on the depth at the station, a piece of core liner at least 5 ft longer than the required core length was loaded into the barrel and secured with a cutter head screwed onto the threaded end of the core barrel. The outer surface of the core barrel was marked with white paint at 1-ft intervals to determine the penetration depth of the sampling device. A 6-ton electric vibratory hammer coupled to the top of the core barrel provided the power to drive the core barrel to the necessary depth.

Collection of the core sample began after the barge was positioned by the tugboat at the marker buoy. Position was maintained during the coring operation by either of two ways, spud or normal anchoring. When possible, the barge was anchored with spuds. Otherwise, two anchors were dropped and the drift of the barge controlled by the tugboat pushing the barge into the wind or current until the anchor cables held the barge in correct position. When the Andrew was in position, the vibratory hammer and core barrel were lifted

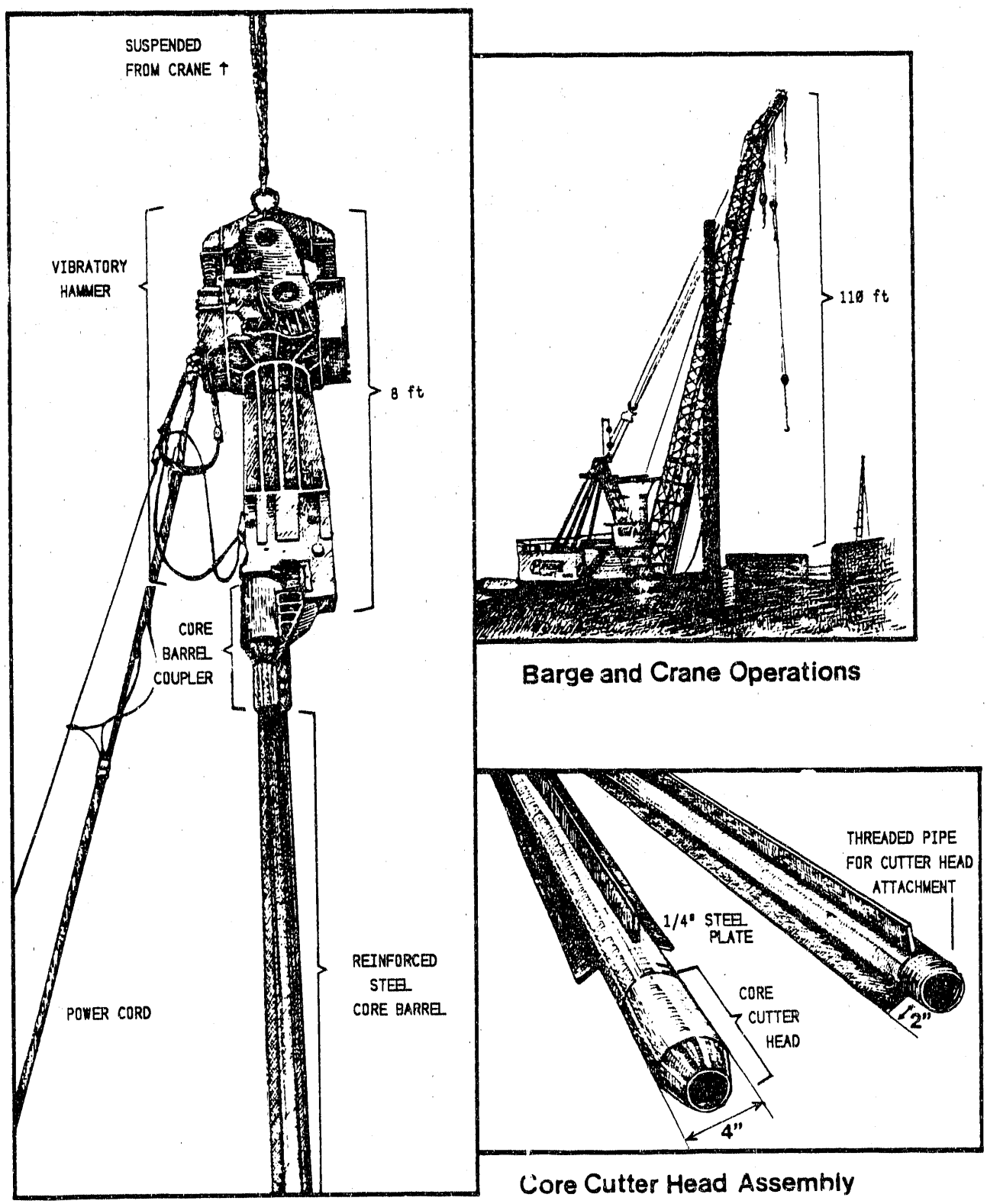


FIGURE 2.1. Vibratory Hammer Coring Device (from Word et al. 1990a,b)

by the 110-ft crane and suspended next to the barge deck. The deck crew secured the core barrel to the side of the barge while the crane operator coupled the vibratory hammer to the core barrel (Figure 2.1). The core barrel was then released from the side of the barge and suspended above the station buoy, where it is lowered to the bottom and allowed to penetrate the sediment under its own weight. If penetration to the desired depth did not occur as a result of the mass of the sampler, the vibratory hammer was activated to drive the core barrel to the necessary depth. At this point, the vibratory hammer was decoupled from the core barrel, and the entire assembly was lifted out of the water by the crane and gently lowered to the deck of the barge.

The cutter head was removed and the sediment-filled core liner was pulled from the core barrel and placed on a working stand. The sediment sample inside the core liner was inspected to ensure that it was long enough and either accepted or rejected. If rejected, another sample was taken. If accepted, the deepest end of the core was capped, the core liner was cut above the sediment/water interface, and this upper end was capped. The core was then labeled, cut into transportable sections, and the ends of each section capped and sealed. The length of core collected, number of sections, and labels assigned to the sections were recorded on the coring log sheet.

2.1.3 Sample Storage and Chain of Custody

Cut and labeled core sections were stored on board the sampling vessel in a freezer maintained at 4°C. At the end of each sampling day, the sections were loaded into a refrigerated truck, also maintained at 4°C. A sediment sample chain-of-custody form accompanied the core samples from the time they were loaded into the truck to the time they were delivered to MSL.

2.2 LABORATORY COMPOSITING

Laboratory compositing consisted of all activities between field collection of cores and chemical analysis of sediment samples. These activities included longitudinal splitting of cores, geological description of core sediments, compositing of sediment samples, sample storage, and sample tracking. The steps involved in laboratory compositing are detailed in the following sections.

2.2.1 Laboratory Glassware and Equipment Preparation

To avoid sample contamination, all laboratory glassware and equipment were cleaned before use. Stainless steel blades, spatulas, spoons, and bowls used for core cutting, sediment mixing, and short-term storage were washed with warm, soapy water, rinsed five times with deionized water, and allowed to air dry. Immediately before use, stainless steel utensils and bowls were rinsed twice with methylene chloride ($MeCl_2$) under a fume hood and allowed to dry. Precleaned glass jars with Teflon-lined caps were purchased and used to contain sediment samples for organics analysis. Plastic jars were used to contain sediments for metals and grain-size analysis. Jars for grain-size analysis were new and required no special cleaning. New plastic jars for metals samples were washed in soapy water, rinsed five times with deionized water, then placed in a 5% nitric acid (HNO_3) bath for a minimum of 4 hr. After removal from the acid, the jars were rinsed five times with deionized water, then air dried.

2.2.2 Core Cutting, Geological Description, and Compositing

After core samples arrived at MSL, they were stored in a walk-in cold room at 4°C until processed. Cores were processed in the same order as they were collected in the field. The only exceptions to this processing order were a few cores from Carquinez Strait and Pinole Shoal berthing areas (CB 4A, CB 1, P XII B1, and P XII B2), which were not cut until USACE approved the processing of cores from non-federal dredging areas. Each John F. Baldwin Ship Channel core sample was cut in half longitudinally, then examined by an MSL geologist and a USACE representative. Geological descriptions were performed according to the American Society for Testing and Materials (ASTM) Procedure D2488-84, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM 1984). Sediment characteristics that were recorded on a geological core log form included the following:

- lithology
- dilatancy of silt/clay
- toughness of silt/clay
- plasticity of silt/clay

- sediment type (i.e., engineering classification)
- color
- consistency (i.e., firmness)
- cementation
- sedimentary structure
- reaction with hydrochloric acid
- maximum particle size
- odor.

In addition, any other diagnostic features such as the presence of root traces, mollusk shells and/or related detritus, or the sediment dry strength were noted.

The USACE representative then decided, based on the length of the core and the geologist's description of sediment characteristics, if and where the core was to be vertically divided into multiple sediment samples. Criteria for dividing the core included discontinuities in sediment type, structure, or particle size, and the volume of material between the mudline and project depth (-47 ft MLLW). If the core was not divided, one sample was mixed from the sediments between the mudline and project depth in that core. If the core was divided, the dividing lines were measured and clearly marked by indentation of the sediment surface. For each sample that was prepared, the sampling station, the section(s) of core making up the sample, and a code number relating the sample to the station were recorded on a compositing/sample preparation form.

To composite, or mix, samples for chemical analysis, sediment from the appropriate segment of each core was removed from the core liner with a stainless steel spatula and placed in a labeled, stainless steel bowl. Care was taken to avoid removing sediment that had been in direct contact with the core liner, or sediment containing flakes of liner resulting from the cutting process. Sediment was mixed with the spatula until the color and texture were homogenous, then transferred to appropriately labeled jars for the various chemical and physical analyses.

2.2.3 Sample Storage and Chain of Custody

Upon delivery at MSL, core samples were stored at 4°C in a walk-in cold room until removed for cutting. Jars containing chemistry samples were stored on ice in coolers or in the cold room until delivered or shipped to analytical laboratories. A chain-of-custody form accompanied each set of samples shipped or transferred to analytical laboratories.

2.3 ANALYTICAL CHEMISTRY

The following sections briefly describe the methods used for analysis of sediment for the required chemical and physical parameters. All methods were consistent with U.S. Environmental Protection Agency (EPA)-approved procedures. A list of the analytes, required analytical detection limits, quality control (QC) requirements, and the number of samples analyzed is presented in Table 2.1.

2.3.1 Sediment Conventionals

2.3.1.1 Grain Size

Grain size of sediment samples was determined by a combination of sieve and pipet techniques, following the Puget Sound Estuary Program (PSEP) Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP 1986). These methods are consistent with ASTM D421 (ASTM 1978) and D422 (ASTM 1972). Approximately 25 g sediment was removed for analysis of total solids, while another 20- to 100-g aliquot was weighed for grain-size analysis. To separate the coarser sand and gravel fraction from the silt/clay fraction, sediment was washed with distilled water through a 62.5-μm (4.0 phi) sieve into a 1-L graduated cylinder. The coarse fraction was dried, weighed, and shaken through a nest of sieves to yield the required seven coarse subfractions. The silt/clay fraction was subdivided by a pipet technique based on Stoke's Law of differential settling velocities for different sized particles. The silt/clay fraction was disassociated by a dispersant in distilled water in a 1-L graduated cylinder. At specified time intervals and specified depths below the surface, 20-mL aliquots of suspension were withdrawn from the graduated cylinder, delivered to a preweighed container, and dried to constant weight at 90° ± 2°C. The grain-size fractions and methods of determination

TABLE 2.1. Analytical Chemistry Requirements for John F. Baldwin Ship Channel Sediment Samples

Measurement	Detection Limits[a], mg/kg	Type and Number of Samples: JFB Sediment	SRM	10% Dups[b]	10% Spikes	Min. Blanks	Total
Conventionals							
TOC	0.1%	65	1	7	N/A	N/A	73
Total oil and grease	20	65	N/A	7	7	5	84
Total petroleum HC	20	65	N/A	7	7	5	84
Grain size	N/A	65	N/A	7	N/A	N/A	72
Metals							
Ag	0.1	65	0	7	7	2	81
Al	10	65	2	7	0	2	76
As	2	65	2	7	0	2	76
Cd	0.1	65	2	7	0	2	76
Co	0.1	65	2	7	0	2	76
Cr	2	65	2	7	0	2	76
Cu	2	65	2	7	0	2	76
Hg	0.02	65	2	7	0	2	76
Ni	2	65	2	7	0	2	76
Pb	2	65	2	7	0	2	76
Se	1	65	0	7	7	2	81
Tl	0.1	65	0	7	7	2	81
Zn	2	65	2	7	0	2	76
Butyltins	0.01	65	2	7	7	2	83
PCBs[c]	0.02	65	2	7	7	2	83
Semi-volatiles[d]	0.02	65	2	7	7	2	83
Pesticides[e]	0.001-0.03	65	1	7	7	2	82

(a) Target detection limits; all efforts were made to reach lowest practical detection limit.
(b) Duplicate jars of composite included in sample shipments to analytical laboratories.
(c) Reported as Aroclor equivalents 1242, 1248, 1254, and 1260, and total.
(d) All compounds on EPA Method 610 list (Appendix C, Table C.8).
(e) All compounds on EPA Method 608 list (Appendix C, Table C.9).
SRM = standard reference material.
N/A = not applicable.

are listed in Table 2.2. Quality control measures included duplicate analysis of 10% of total samples. Spikes, standard reference materials, or minimum detection limits do not apply to grain-size analysis.

TABLE 2.2. Sediment Grain Size Fractions and Method of Determination Used in Grain-Size Analysis of John F. Baldwin Ship Channel Samples

Grain Size, μm	Phi	Sieve Number	Pipet Depth, cm	Time of Pipet Sampling hr	min	sec
> 4750	<-2.25	4	N/A	N/A		
4750-2000	-2.25	10	N/A	N/A		
2000-850	-1.00	20	N/A	N/A		
850-425	0.25	40	N/A	N/A		
425-250	1.25	60	N/A	N/A		
250-106	2.00	140	N/A	N/A		
106-75	3.25	200	N/A	N/A		
75-62.5	3.75	230	N/A	N/A		
62.5-31.2	4.00	N/A	20	0	0	20
31.2-15.6	5.00	N/A	10	0	1	55
15.6-7.8	6.00	N/A	10	0	7	41
7.8-3.9	7.00	N/A	10	0	31	0
3.9-1.9	8.00	N/A	10	2	3	0
1.9-0.9	9.00	N/A	7	5	43	0
0.9-0.4	10.0	N/A	7	22	53	0
0.4-0.2	11.0	N/A	5	65	25	0

2.3.1.2 Total Organic Carbon

The TOC measurement includes the amount of nonvolatile, partially volatile, volatile, and particulate organic compounds in a sample. The TOC in sediment was determined by measuring the carbon dioxide released during combustion of the sample (PSEP 1986; SW846 Method 9060 EPA 1986a). Before combustion, inorganic carbonate was removed by acidification. Quality control measures included duplicate analysis on 10% of the samples and analysis of the SRM MESS-I. Results are reported as percent of dry weight.

2.3.1.3 Oil and Grease and Petroleum Hydrocarbons

Total oil and grease includes vegetable oils, animal fats, soaps, waxes, and any other carbon-hydrogen material extractable by Freon solvent. Total petroleum hydrocarbons are the mineral fraction of total oil and grease. Infra-red spectrophotometry (IR) is used to determine concentrations of oil and grease (Method 413.2, EPA 1979) and petroleum hydrocarbons (Method 418.1, EPA 1979). A 20-g aliquot of sample was dried with anhydrous sodium sulfate, then extracted with Freon on a rolling-mill sample homogenizer.

For total oil and grease, sample extracts were scanned from 4000 to 600 cm^{-1} on an infrared spectrophotometer and the peak height measured at 2930 cm^{-1}. This wavelength represents the $-CH_2$ configurations of hydrocarbons and was the standard used to determine oil and grease. For total petroleum hydrocarbons, the extract was run through silica gel to remove the animal- and vegetable-based oils and scanned the same way as for oil and grease. The relationship of peak height to the oil concentration was determined by regressing the peak height versus a known concentration of fuel oil.

2.3.2 Metals

Thirteen metals were measured in John F. Baldwin Ship Channel sediment: silver (Ag), aluminum (Al), arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), selenium (Se), thallium (Tl), and zinc (Zn). Eight metals (Al, As, Cr, Cu, Ni, Pb, Se, and Zn) were measured by energy-diffusive X-Ray fluorescence (XRF) following the method of Nielson and Sanders (1983). Mercury was analyzed by cold-vapor atomic absorption spectroscopy (CVAA) (SW846 Method 7471, EPA 1986a; Bloom and

Crecelius 1983), while Ag, Cd, Co, and Tl were analyzed by Zeeman graphite-furnace atomic absorption spectroscopy (GFAA) (SW846 7000 series, EPA 1986a; Bloom and Crecelius 1984).

To prepare sediments for analysis, samples were freeze-dried, then blended in a Spex mixer-mill. Approximately 5 g of mixed sediment was ground in a ceramic ball mill. The XRF analysis was performed on a 0.5-g aliquot of dried, ground sediment pressed into a pellet of 2 cm diameter. For GFAA and CVAA analysis, 0.2-g aliquots of dried homogenate went through an acid digestion process to separate and isolate the metals from the sediment. Quality control measures for metals analysis included analysis of blanks (not applicable to XRF technique), 10% duplicates, and two SRMs: National Bureau of Standards (NBS) SRM 1646 and National Research Council of Canada (NRCC) SRM MESS-1. Because there are no certified SRM values for Ag and Tl, matrix spikes were analyzed to assess accuracy of Ag and Tl measurements.

2.3.3 Butyltins

Butyltin compounds were analyzed using gas chromatography with flame photometric detection (GC-FPD) following the methods of Unger et al. (1986). Approximately 10 g of wet sediment was weighed into a solvent-rinsed jar, dried with anhydrous sodium sulfate, then extracted from sediment with 110 mL $MeCl_2$ and 0.25 g tropolone. Propyltin was added before extraction as a surrogate compound to assess extraction efficiency. The extract was decanted through silanized glass wool to remove particles, and the container rinsed three times with $MeCl_2$ to ensure that all extracted material was recovered. The mono-, di-, and tri-butyltin compounds extracted from the sediment were derivatized with n-hexyl magnesium bromide to a less volatile, more thermally stable form (nonionic n-hexyl derivatives).

The extracts were passed through a florisil liquid chromatography column for cleanup, and the butyltins quantified by GC-FPD. Concentrations were reported as $\mu g/kg$ dry weight of mono-, di-, and tri-butyltin species and a calculated total obtained by adding the concentrations of detected species (as opposed to a measured total). The recently certified NRCC SRM PACS-1 for butyltins was analyzed along with John F. Baldwin Ship Channel sediments; the National Oceanic and Atmospheric Administration's (NOAA) reference material

SQ-1 was also analyzed. Although not a "standard" (NBS or otherwise certified) reference material, SQ-1 contains a consistently measurable amount of butyltins and is routinely analyzed by MSL.

2.3.4 Semivolatile Organic Compounds

The semivolatile organic compounds analyzed in John F. Baldwin Ship Channel sediments are the 16 polynuclear aromatic hydrocarbons (PAHs) listed in EPA Method 610. These compounds were extracted from sediments and analyzed by gas chromatography/mass spectroscopy (GC/MS) following EPA SW846 Method 8270 (capillary column technique) (49 FR 112-117).

The percent moisture in each sample was determined from one aliquot of sediment. Another aliquot was mixed with sodium sulfate, spiked with the appropriate base/neutral surrogate standards (nitrobenzene-d5, 2-fluorobiphenyl, and terphenyl-d14), then extracted with $MeCl_2$ in a Soxhlet extractor. The extract was concentrated to less than 10 mL in a Kuderna-Danish concentrator and then reduced to a final volume of 200 μL under a flow of clean nitrogen gas. The internal quantitation standards were added to the extract and the extract analyzed by GC/MS. The 200-μL final extract volume and five-fold dilutions of internal standards were modifications to the method that resulted in lower detection limits. Detection limits for the PAH compounds were calculated from the results of analyses of seven low-level spike replicate samples, using clean sand as the spiking matrix.

Quality control measures included analyzing blanks, using matrix spikes on 10% of samples for accuracy, duplicating 10% of the samples for precision, and analyzing seven compositing duplicates. In addition, two SRMs from NRCC were analyzed, HS-3 and SES-1. The percent recoveries of the surrogate compounds were also reported; samples for which surrogate recovery control limits in EPA Method 8270 (EPA 1986a) were not met were reextracted and reanalyzed.

2.3.5 Chlorinated Pesticides and Polychlorinated Biphenyl(s) (PCBs)

Chlorinated pesticides and PCBs in sediments were quantified by gas chromatography/electron capture detection (GC/ECD) following EPA SW846 Method 8080 (EPA 1986a). Chlorinated pesticides and PCBs were extracted overnight in a Soxhlet extractor, and the solvent was exchanged to hexane for GC/ECD analysis. Dibutylchlorendate (DBC) was the surrogate compound added to each

sample before extraction to assess extraction efficiency. The matrix spiking solution was also added to the appropriate samples before extraction. Matrix spikes were conducted on 10% of the samples to assess accuracy of measurements; another 10% were duplicated to assess analytical precision. Two reference materials were analyzed, NOAA's SQ-1, which is not "standard," but has been routinely analyzed for pesticides and PCBs, and NRCC SRM HS-1, which has a certified concentration of PCB. At least one method blank was analyzed for every 20 samples.

3.0 RESULTS AND DISCUSSION

3.1 CORE SAMPLING AND COMPOSITING

The field sampling effort in the John F. Baldwin Ship Channel was completed between September 5 and 12, 1989. All 49 of the planned stations were visited during this period. Core samples were successfully collected at the nine sampling sites in the West Richmond reach (Figure 3.1), and at all 30 sites in Pinole Shoal (Figure 3.2). In Carquinez Strait (Figure 3.3), two planned stations near the Shell and Amorco docks along the southern edge of the channel were rejected because the sites were already deeper than the project depth of -47 ft MLLW (-45 ft plus 2 ft overdepth). One station (CB 4A) was added in Carquinez Strait for a total of nine sites sampled in that reach. In all, 48 core samples were collected. Complete core sampling information is provided in Table 3.1.

Upon arrival at MSL, cores were cut and samples for sediment chemistry composited during Task 4 (Laboratory Compositing) of the John F. Baldwin Program (see Section 2.2). Core cutting, geological description, and sample preparation were completed between September 14 and 21, 1989. Following the guidance of the geologist and the USACE representative, 20 of the cores were divided into 2 vertical sections that were then homogenized into sediment samples, while 1 core was divided into 3 samples; 1 sample was prepared from each of the remaining 27 cores. In total, 75 sediment samples plus 7 compositing duplicates (two aliquots from the same bowl of homogenized sediment) were prepared from the 48 cores.

Of the 75 samples, 70 were analyzed, while 5 were archived until local sponsors agree to fund the analyses. The archived samples were from Stations CB 2 (1 sample), P XIII B3 (2 samples), and P XIII B4 (two samples). These stations represent berthing areas that are not federally maintained. To archive samples, composited sediments were placed in labeled, solvent-rinsed, 1-L jars and stored at 4°C in the walk-in cold room at MSL. These archived samples are available for chemical analysis, although the holding time has been exceeded for certain analyses.

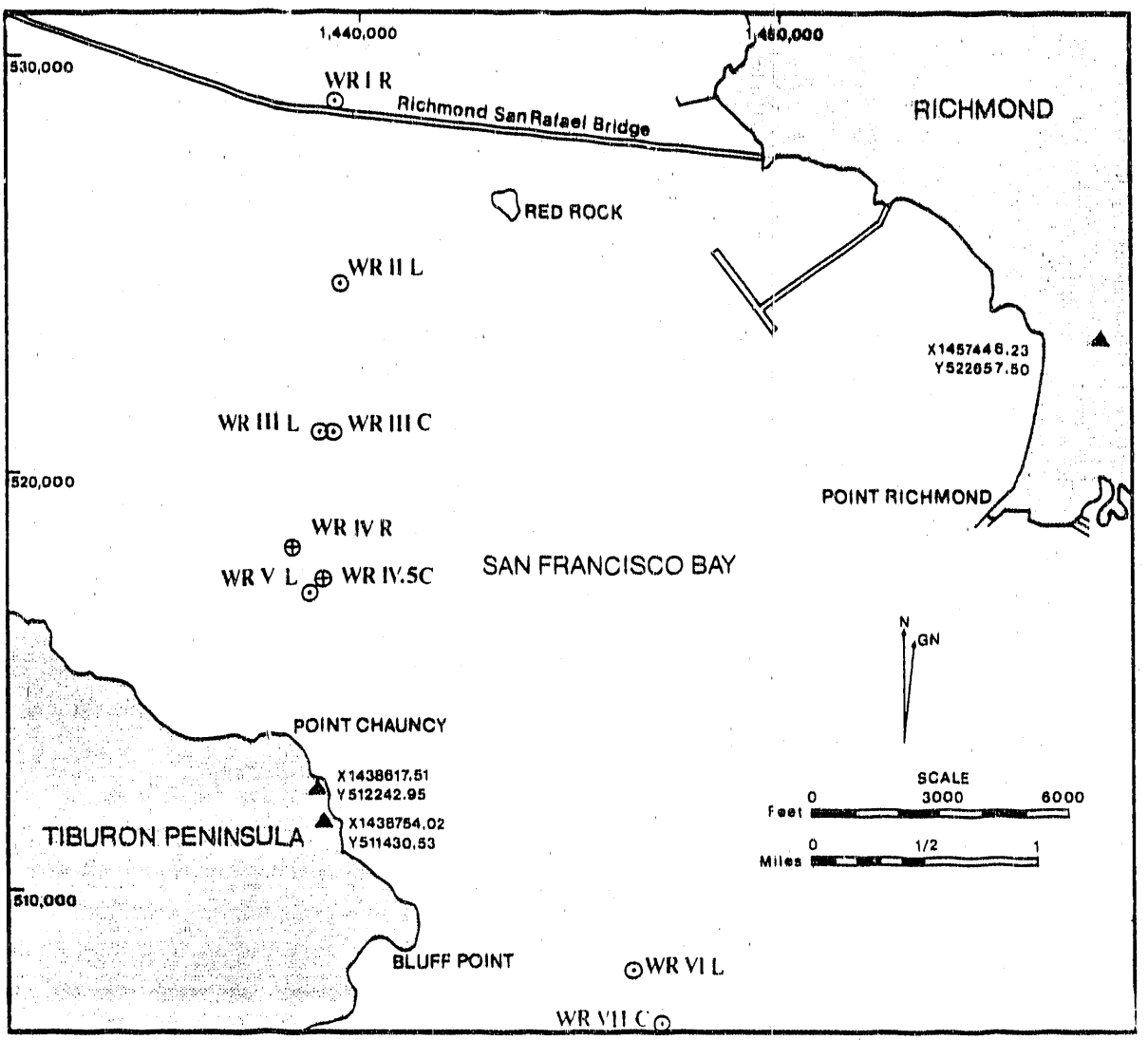


FIGURE 3.1. Sampling Sites in West Richmond Reach of John F. Baldwin Ship Channel (⊙=1 sample analyzed; ⊕=2 samples analyzed)

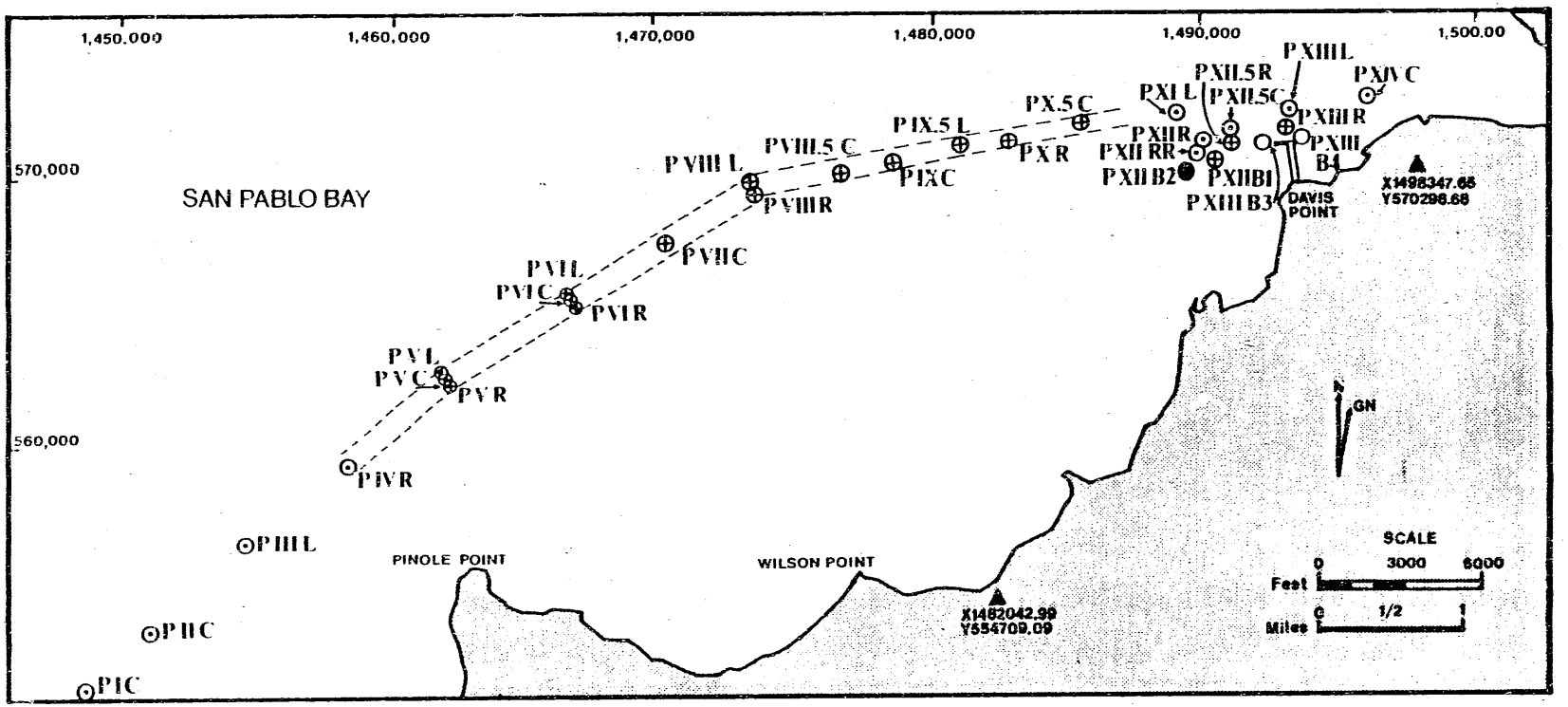


FIGURE 3.2. Sampling Sites in Pinole Shoal Reach of John F. Baldwin Ship Channel (○=0 samples analyzed; ⊙=1 sample analyzed; ⊕=2 samples analyzed; ◉=3 samples analyzed)

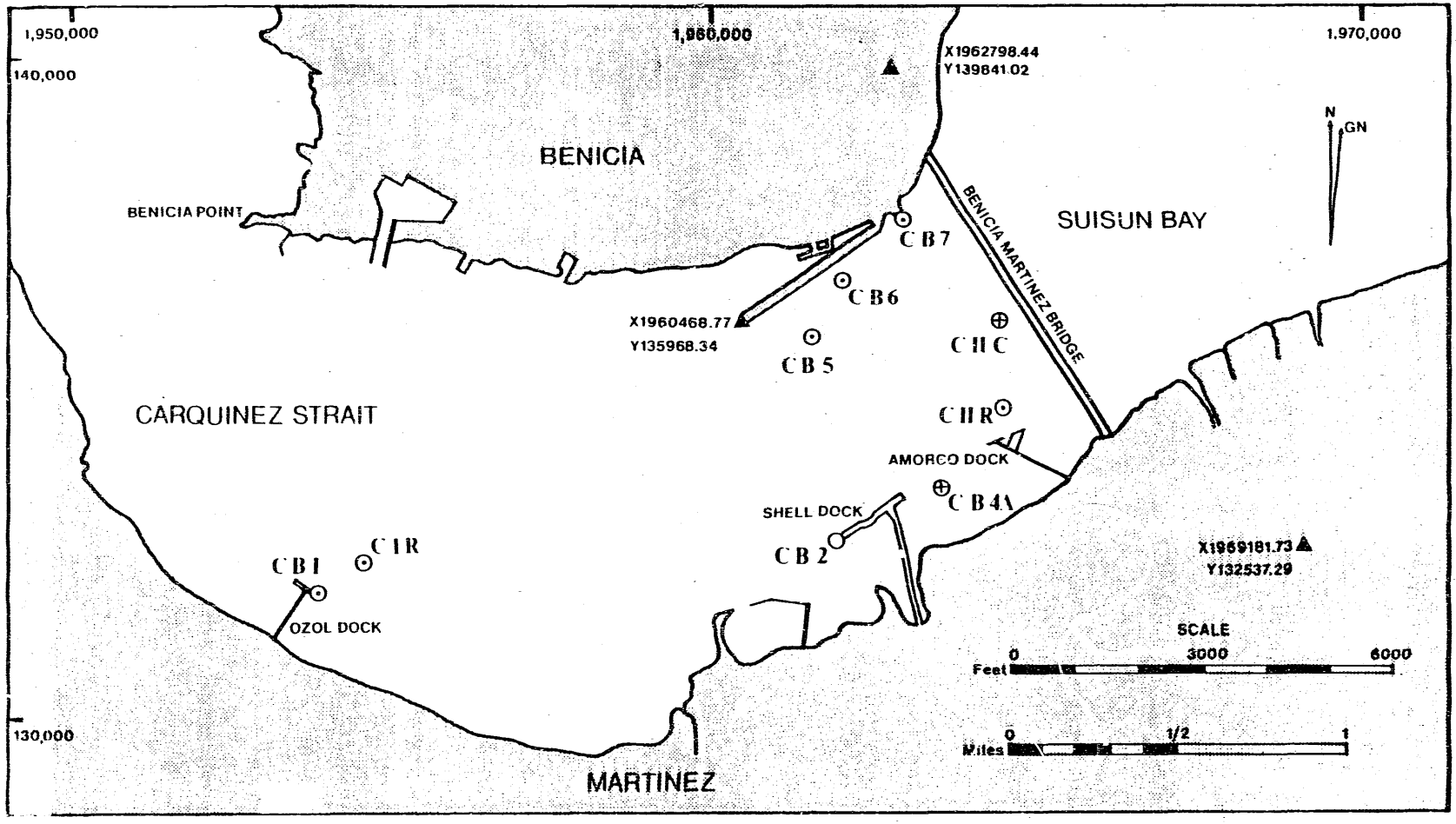


FIGURE 3.3. Sampling Sites in Carquinez Strait Reach of John F. Baldwin Ship Channel (O=0 samples analyzed; ⊙=1 sample analyzed; ⊕=2 samples analyzed)

TABLE 3.1. Core Sampling and Compositing Information for John F. Baldwin Ship Channel Stations

Station	California State Plane Coordinates Y, Northing	X, Easting	Date Sampled	Water Depth, ft MLLW	Ft Core Required to -47 ft MLLW	Ft Core Collected	Comments	Date Composited	Number Samples
West Richmond (California State Zone III)									
WR VII C	506,490	1,446,650	09-07-89	41.5	5.5	6.5	7 attempts before success	09-14-89	1
WR VI L	507,710	1,446,070	09-07-89	43.0	4.0	8.2	Kept upper 5 ft	09-14-89	1
WR V L	517,103	1,438,724	09-07-89	41.0	6.0	6.5		09-14-89	1
WR IV.5 C	517,495	1,438,847	09-07-89	39.7	7.3	10.5		09-14-89	2
WR IV R	518,178	1,438,369	09-12-89	35.5	11.5	14.0		09-19-89	2
WR III L	520,991	1,438,861	09-12-89	40.4	6.6	13.0	Kept upper 7.6 ft	09-19-89	1
WR III C	520,992	1,439,072	09-12-89	40.6	6.4	10.0	Kept upper 7.4 ft	09-19-89	1
WR II L	524,226	1,439,379	09-12-89	40.1	6.9	11.5	Kept upper 8 ft	09-19-89	1
WR I R	528,590	1,439,299	09-12-89	41.9	5.1	7.0	Kept upper 6.5 ft	09-19-89	1
Pinole Shoal (California State Zone III)									
P I C	551,186	1,448,210	09-11-89	44.0	3.0	7.2	Kept upper 4 ft	09-19-89	1
P II C	554,048	1,450,768	09-11-89	42.7	4.3	8.4	Kept upper 5.3 ft	09-19-89	1
P III L	557,302	1,454,274	09-11-89	44.0	3.0	8.0	Kept upper 4 ft	09-19-89	1
P IV R	560,115	1,458,253	09-11-89	39.0	8.0	13.5	Kept upper 9 ft	09-19-89	1
P V L	563,465	1,461,846	09-11-89	38.6	8.4	12.5	Kept upper 9.5 ft	09-19-89	1
P V C	563,244	1,461,981	09-11-89	38.3	8.7	14.0	Kept upper 10 ft	09-19-89	1
P V R	563,059	1,462,094	09-11-89	36.5	10.5	13.9	Kept upper 11.5 ft	09-19-89	2
P VI L	566,244	1,466,551	09-11-89	35.4	11.6	14.0	Kept upper 11.6 ft	09-18-89	2
P VI C	566,069	1,466,624	09-11-89	38.0	9.0	13.0	Kept upper 10 ft	09-18-89	1
P VI R	565,870	1,466,777	09-11-89	35.3	11.7	13.7	Kept upper 12.7	09-18-89	2
P VII C	568,105	1,470,198	09-11-89	36.9	10.1	14.5	Kept upper 11.5 ft	09-18-89	2
P VIII L	570,249	1,473,544	09-10-89	37.5	9.5	14.0	Kept upper 10.5 ft	09-18-89	2
P VIII R	569,775	1,473,806	09-10-89	36.5	10.5	14.5	Kept upper 11.5 ft	09-18-89	2
P VIII.5 C	570,630	1,476,526	09-10-89	36.6	10.4	11.5		09-18-89	2
P IX C	570,933	1,478,421	09-10-89	36.2	10.8	13.0	Kept upper 11.8 ft	09-18-89	2
P IX.5 L	571,551	1,480,937	09-10-89	36.9	10.1	14.0	Kept upper 11.5 ft	09-18-89	2
P X R	571,519	1,482,791	09-10-89	35.5	11.5	12.2		09-18-89	2

TABLE 3.1. (contd)

Station	California State Plane Coordinates Y, Northing	X, Easting	Date Sampled	Water Depth, ft MLLW	Ft Core Required to -47 ft MLLW	Ft Core Collected	Comments	Date Composited	Number Samples
Pinole Shoal, contd									
P X.5 C	572,236	1,485,358	09-10-89	36.6	10.4	13.9		09-15-89	2
P XI L	572,663	1,487,604	09-10-89	43.5	3.5	6.7	Kept upper 4.5 ft	09-15-89	1
P XII R	571,423	1,489,548	09-09-89	38.5	8.5	12.0	Kept upper 10 ft	09-15-89	1
P XII RR	571,167	1,489,570	09-09-89	37.8	9.2	9.9		09-15-89	1
P XII B2	570,683	1,489,481	09-09-89	34.5	12.5	14		09-19-89	3
P XII B1	571,051	1,490,122	09-09-89	35.9	11.1	12.5		09-19-89	2
P XII.5 C	571,863	1,490,801	09-09-89	41.0	6.0	10.0	Kept upper 7 ft	09-15-89	1
P XII.5 R	571,342	1,490,814	09-09-89	31.0	16.0	14.5	Peat layer, bottom 1.5 ft	09-15-89	2
P XIII L	572,670	1,493,016	09-09-89	40.7	6.3	9.8	Kept upper 7.5 ft	09-15-89	1
P XIII R	571,963	1,493,176	09-09-89	37.2	9.8	10.7		09-15-89	2
P XIII B3	571,540	1,492,640	09-09-89	35.3	11.7	11.7		09-15-89	2[a]
P XIII B4	571,700	1,493,300	09-09-89	39.0	8.0	9.0	Very abrupt slope, 10 attempts	09-15-89	2[a]
P XIV C	573,010	1,495,892	09-09-89	42.6	4.4	6.9	Kept upper 5.5 ft	09-15-89	1
Carquinez Strait (California State Zone II)									
CB 1	131,972	1,953,947	09-08-89	40.4	6.6	6.9		09-19-89	1
C I R	132,351	1,954,498	09-08-89	39.0	8.0	9.0		09-14-89	1
CB 2	132,656	1,961,899	09-08-89	40.2	6.8	9.0		09-14-89	1[a]
CB 3	Station Rejected		09-08-89	> 48	N/A[b]	N/A	Below project depth	N/A	0
CB 4	Station Rejected		09-08-89	> 48	N/A	N/A	Below project depth	N/A	0
CB 4A	133,565	1,963,508	09-08-89	35.6	11.4	11.7		09-19-89	2
CB 5	135,907	1,961,546	09-08-89	43.0	4.0	3.8	4 attempts before success	09-14-89	1
CB 6	136,606	1,962,079	09-08-89	40.5	6.5	8.3	Kept upper 7.5 ft	09-14-89	1
CB 7	137,509	1,963,057	09-08-89	43.9	3.1	5.0		09-15-89	1
C II C	135,914	1,964,338	09-08-89	40.7	6.3	6.8		09-14-89	2
C II R	134,760	1,964,403	09-08-89	44.6	2.4	6.0	Kept upper 3.4 ft	09-14-89	1

(a) This number of samples were composited, but were not chemically analyzed because of their location in berthing areas not maintained by USACE.
(b) N/A = not applicable.

3.2 GEOLOGY

In this section, the general geology of the John F. Baldwin Ship Channel sediments is described based on the 48 core samples collected in September 1989. The West Richmond, Pinole Shoal, and Carquinez Strait reaches are discussed individually in Sections 3.2.1, 3.2.2, and 3.3.3 respectively. Three geologic units are present in the John F. Baldwin Ship Channel study area, the Older Bay Mud, Sand Deposits, and Younger Bay Mud (YBM) (USACE 1975a). The oldest unit is the Older Bay Mud, which consists primarily of firm clay, silt, sand, and small gravels deposited during the last interglacial period when sea level resided as much as 335 ft below its present level (USACE 1975b, 1979). None of the core samples penetrated the Older Bay Mud unit.

Sand deposits form an interfingering unit with the underlying Older Bay Mud and the overlying Younger Bay Mud; thickness of the sand deposits is not uniform throughout, being generally thicker along bay margins. The sand deposits are fine grained and mixed with considerable silt and clay; the unit is believed to represent alluvial fans formed by fluviatile current action during shoreline fluctuation during the Pleistocene (USACE 1975a). Although considerable amounts of fine sands are present in several cores, it is unlikely that they represent the Sand Deposit unit because of the relatively shallow depths penetrated during core sampling (Table 3.1).

The Younger Bay Mud consists of mostly soft, dark-colored sediments deposited in an estuarine environment. These deposits were laid down as sea level rose following the last ice age, which ended approximately 12,000 years ago (Barry 1983). The YBM unit appears to form a continuous blanket across the harbor bottom. The YBM unit consists mostly of very soft to soft silty clays and clayey silts with minor amounts of organic material, fine sand and shell fragments (USACE 1975a). In the John F. Baldwin Ship Channel area, especially in San Pablo Bay, the YBM sediments consisted primarily of sand rather than the typically finer silts and clays. Soil colors ranged from dark gray to dark olive gray to black. Dark colors, in combination with the odor of rotten eggs (i.e., hydrogen sulfide), are indications of chemically reducing conditions. The shallow nature of the sediment cores would suggest that the primary unit represented in the John F. Baldwin Ship Channel sampling area

is the YBM. The YBM unit is not restricted to the present bay area, but also lies above sea level a considerable distance inland (USACE 1975a). This suggests that sea level has been higher at times in the past.

3.2.1 West Richmond

A total of nine cores, ranging in length from 5 to 12.6 ft, were characterized from the West Richmond reach of the John F. Baldwin Ship Channel. Only the YBM unit was present in the cores. Figure 3.4 shows a cross section along the length of the West Richmond sampling area. The southern half of the West Richmond sampling area (WR VII C through WR IV.5 C) consisted of dark to very dark olive gray sand. In the northern portion of West Richmond, the sand begins to be replaced by silts and clays. Similar characteristics in cores from West Richmond included the presence of alternating layers of organic-rich sand and silty clay. Most sediments entering the bay system were probably deposited during periods of maximum runoff and turbulence associated with winter storms. These storm deposits produced normally graded sequences of varying thickness depending on distance from the source and the amount of sediment in suspension. Movement toward the channel axis is to an area of higher energy, which results in deposition of the sand but continued suspension of the fines. The areas of greatest sediment accumulation are where the bottom of the bay is not affected by storms and current; it is in these areas of low energy where the fines settle out of suspension to create extensive deposits of silt and clay. The maximum particle size was coarse sand found in the southern portion of the study area. These cores generally had a firmer consistency, less organic fragments, and less fines.

All West Richmond cores contained shell fragments and varying amounts of organic material in the form of rootlets and wood fragments; three cores in the central sampling area contained worm burrows complete with live worms. The rootlets and wood fragments are of terrestrial origin, deposited during storms. No petroleum odors were noted, but a hydrogen sulfide odor was present in several cores 1 to 2 ft below the mudline. Colors of the West Richmond sediments ranged from dark olive gray to dark gray to black, typical of the YBM unit, with no overall trends throughout the sample area; the dark soil colors combined with the presence of a sulfide odor suggests the presence of chemically reduced conditions.

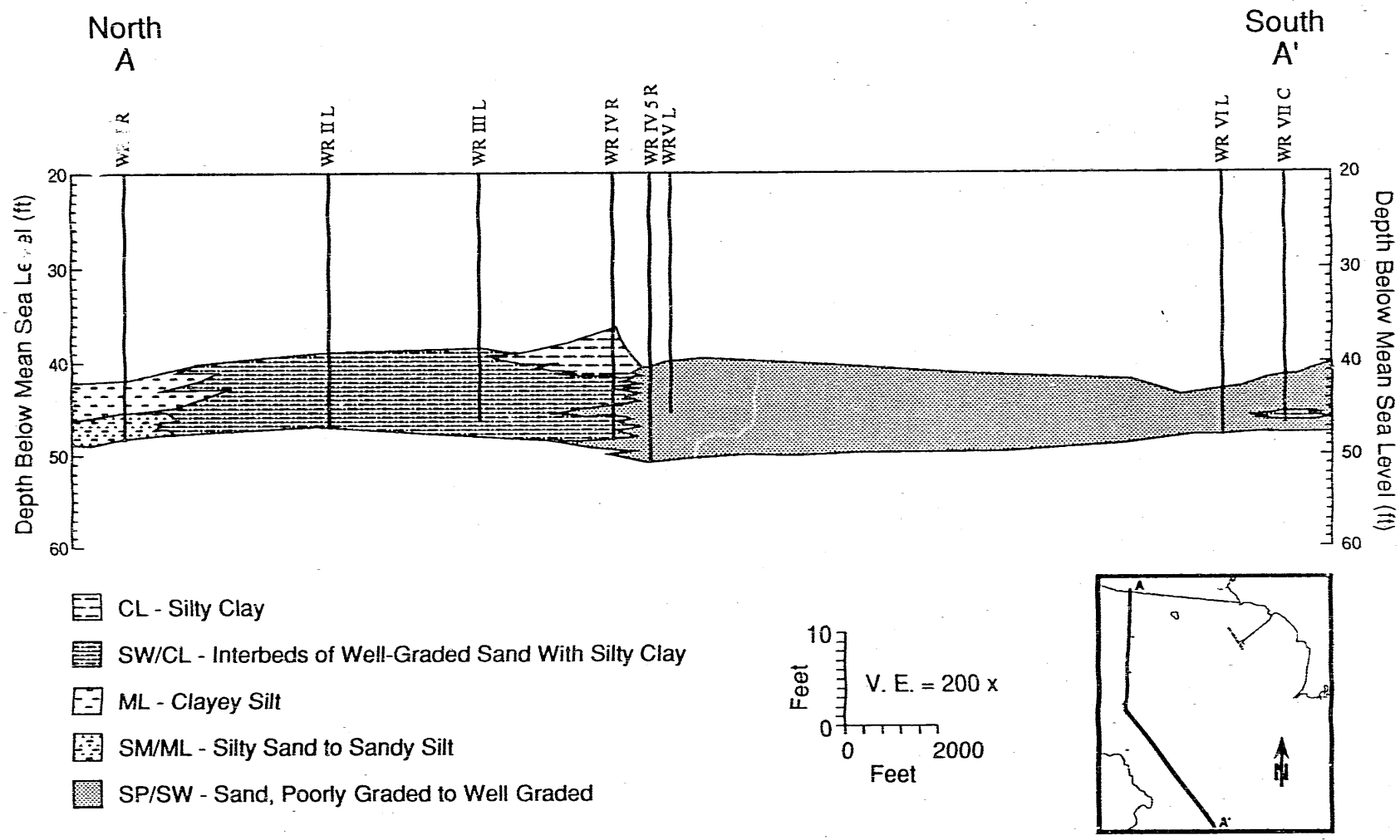


FIGURE 3.4. Sediment Lithology Along the West Richmond Reach of the John F. Baldwin Ship Channel, San Francisco Bay, California

3.2.2 Pinole Shoal

Thirty-seven cores, ranging from 4 to 13.7 ft in length, were characterized for the Pinole Shoal reach of John F. Baldwin Ship Channel in San Pablo Bay. Only the YBM unit is represented within the sediment cores. Figure 3.5 shows a cross section along the length of the Pinole Shoal reach. The eastern portion of the sample area is located at the mouth of Mare Island Strait and Carquinez Strait Channels. Sediments are transported as bedload and suspended load through these constricted channels to San Pablo Bay. Once the sediment-laden waters arrive in the open bay, the loss of velocity results in a diminished ability to carry the sediment load (USACE 1975a). As an example, cores composed primarily of sand and silty sand in the constricted eastern portion of the bay grade into silts and clay with sand to the west and southwest (Figures 3.5 and 3.6).

Isolated sand and clay lenses within the sample area (Figures 3.7 and 3.8) can be attributed to changes in current competency because of sudden freshwater inflow from seasonal storms or fluctuations in tidal currents. Cores contain numerous organic-rich pods, small pebbles, and shell fragments, which were presumably introduced to the bay by such influx. A cross section perpendicular to the channel in Pinole Shoal (Figure 3.9) contains sand deposits in the central channel, which become finer grained toward the channel boundaries; this is consistent with the strongest currents being present in the channel axis and a decrease in current competency away from the axis.

Cores from Pinole Shoal contained fewer shell fragments than both Carquinez Strait and West Richmond sample areas, but exhibited a higher percentage of organic-rich material. Most organic-rich zones occur as isolated pods composed of small branches, twigs, and rootlets of terrestrial origin. Core P XII.5 R penetrated an organic-rich zone from 10 to 11.1 ft below mudline; the initial 0.5 ft consisted of organic soil grading into peat from 10.5 to the core bottom at 11.1 ft. Because the peat layer was found in only one core, the total thickness and lateral extent of the peat deposit cannot be determined, although it may be presumed that such a deposit accumulated in a marsh-type environment during periods of lower sea level. The age of the peat

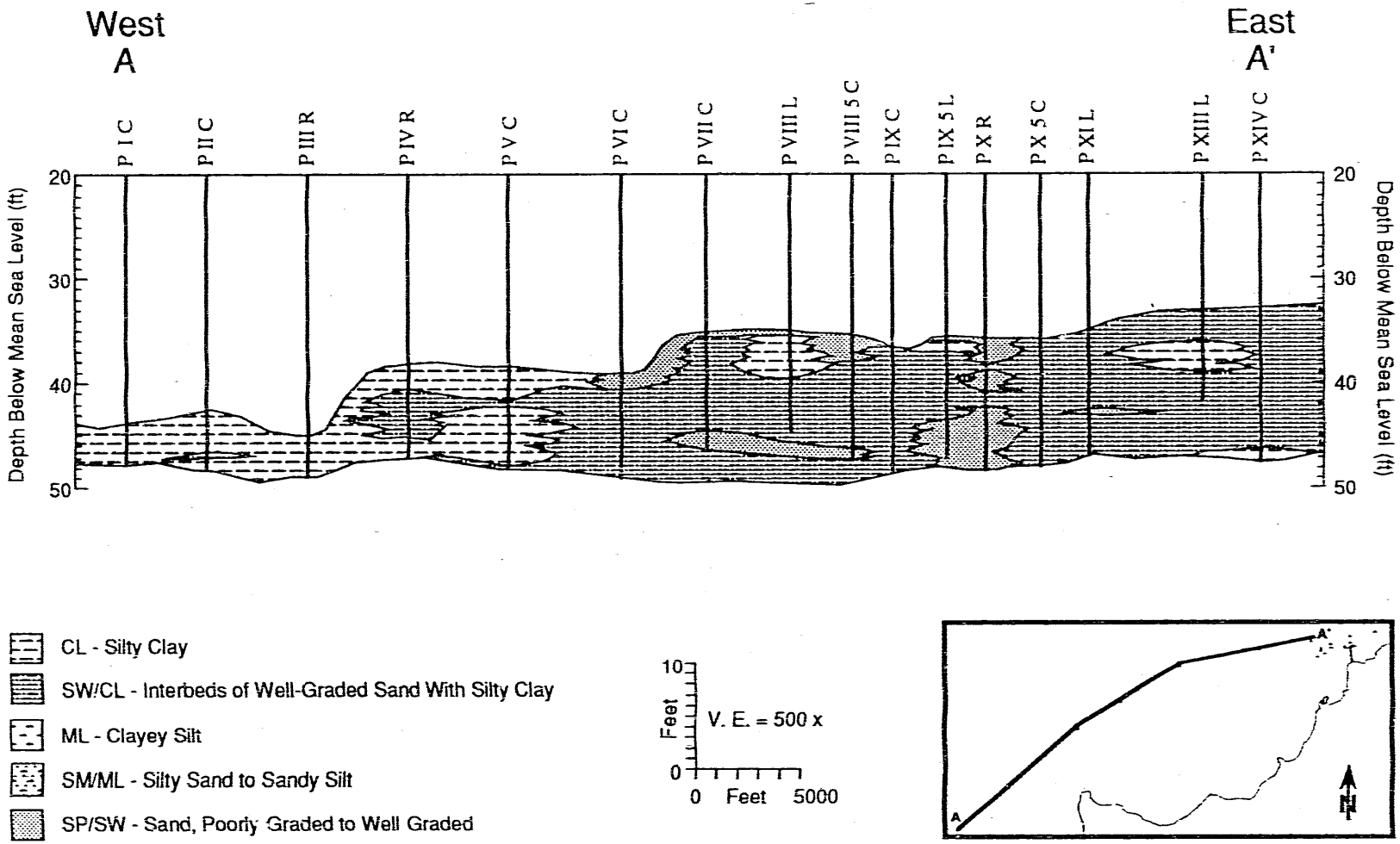


FIGURE 3.5. Sediment Lithology Along the Pinole Shoal Reach of the John F. Baldwin Ship Channel in San Pablo Bay, California

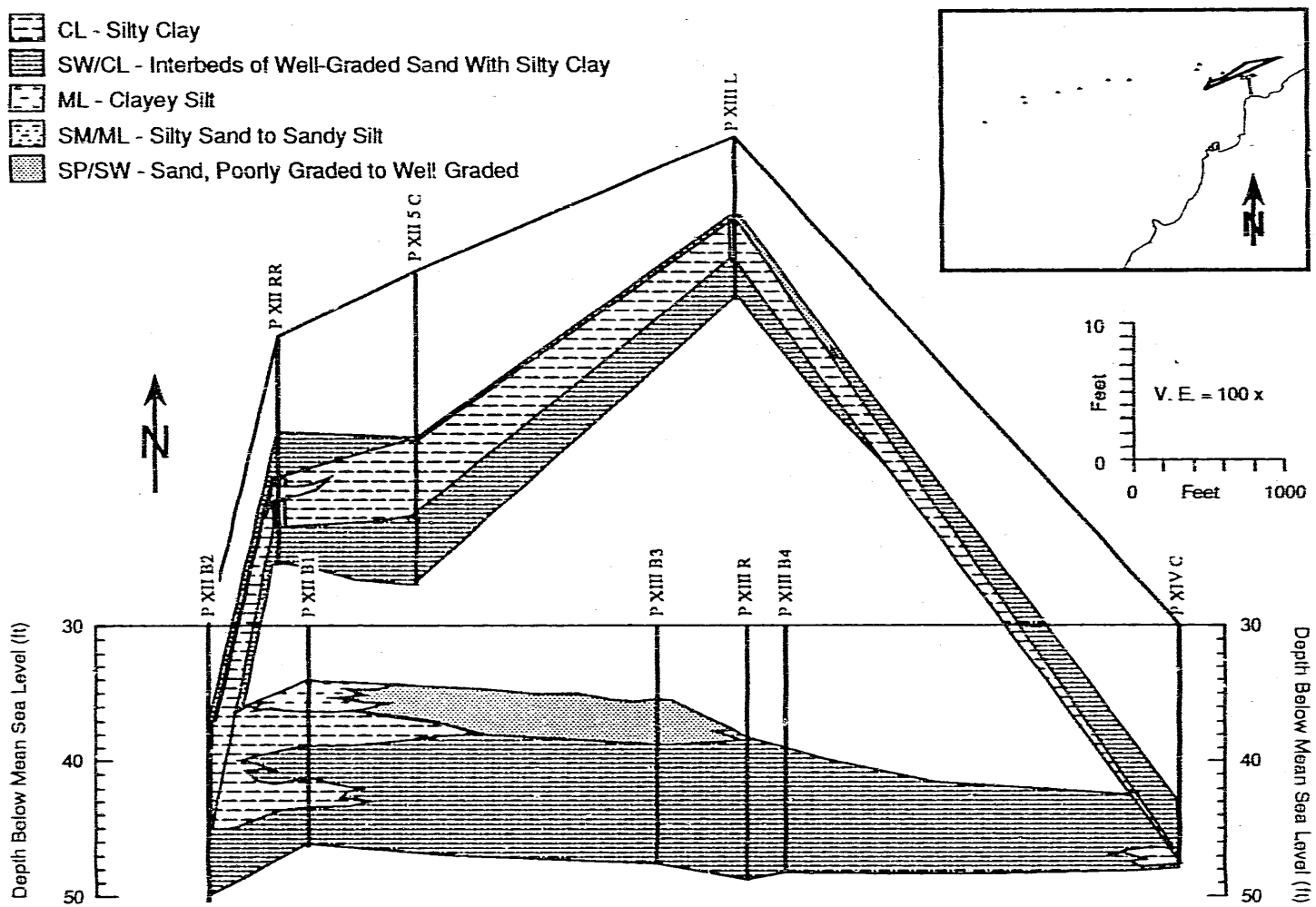


FIGURE 3.6. Sediment Lithology at the Northeastern End of Pinole Shoal Reach, John F. Baldwin Ship Channel, San Pablo Bay, California

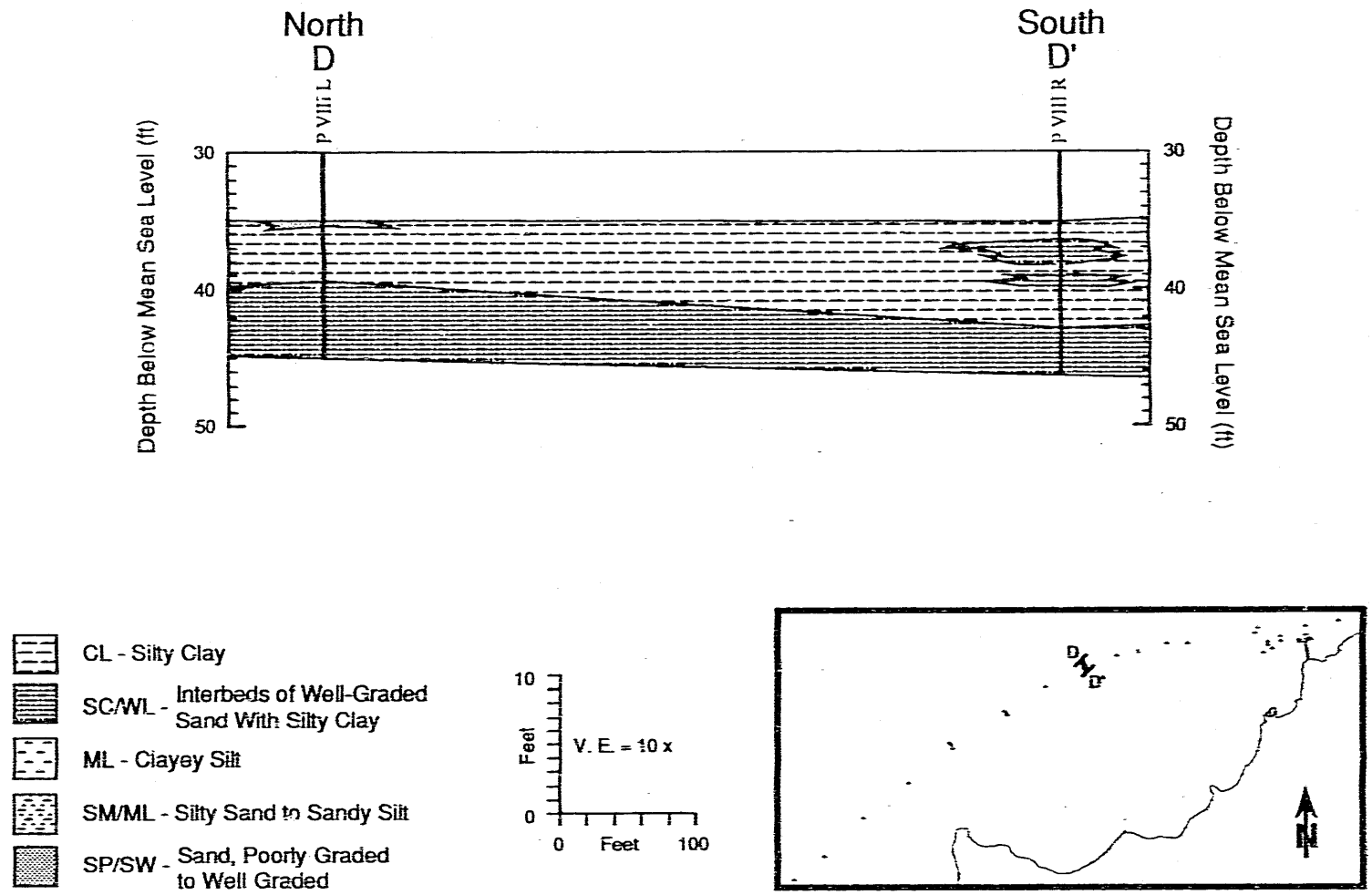


FIGURE 3.7. Sediment Lithology at Transect VIII of Pinole Shoal Reach, John F. Baldwin Ship Channel, San Pablo Bay, California

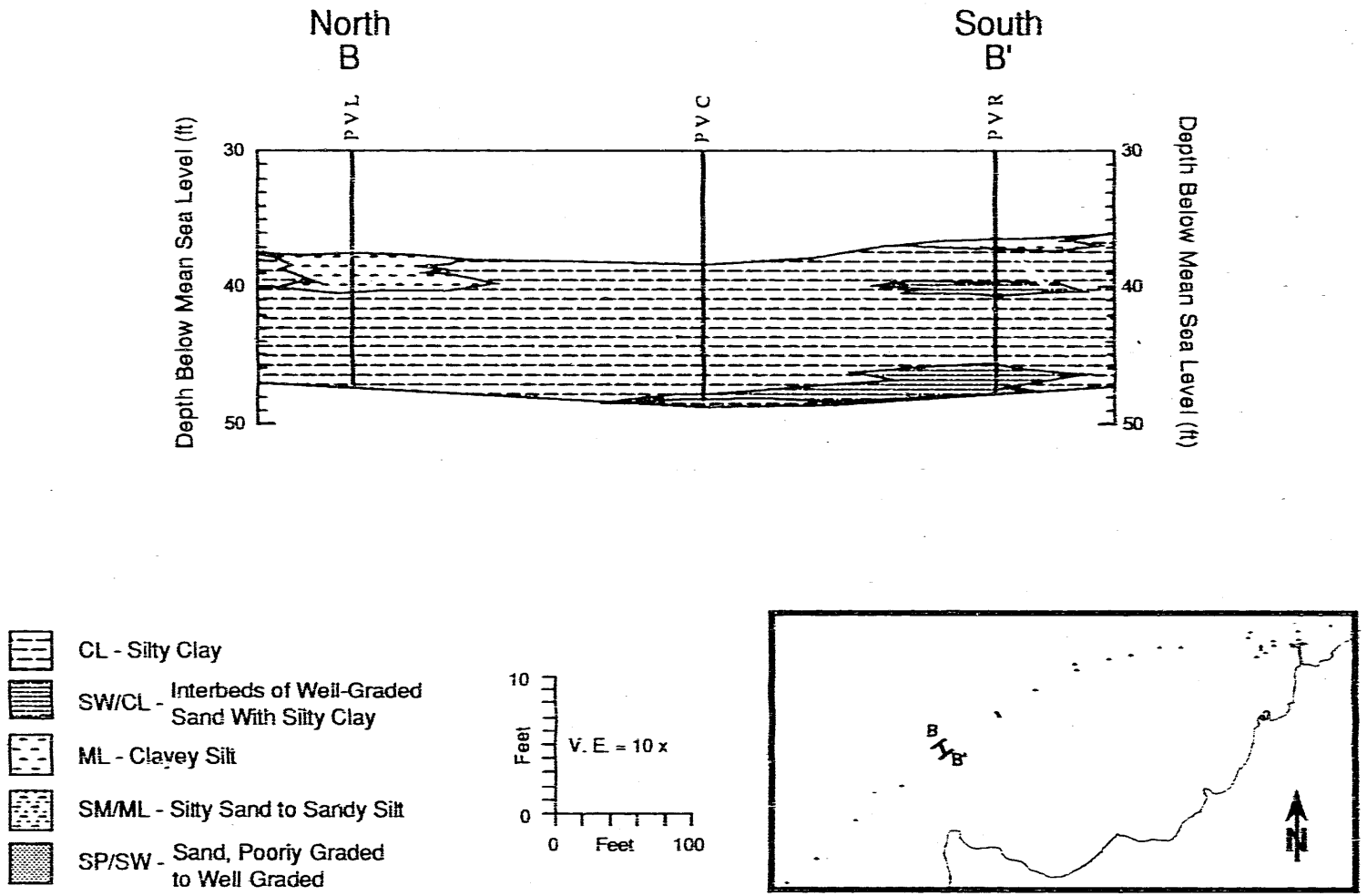


FIGURE 3.8. Sediment Lithology at Transect V of Pinole Shoal Reach, John F. Baldwin Ship Channel, San Pablo Bay, California

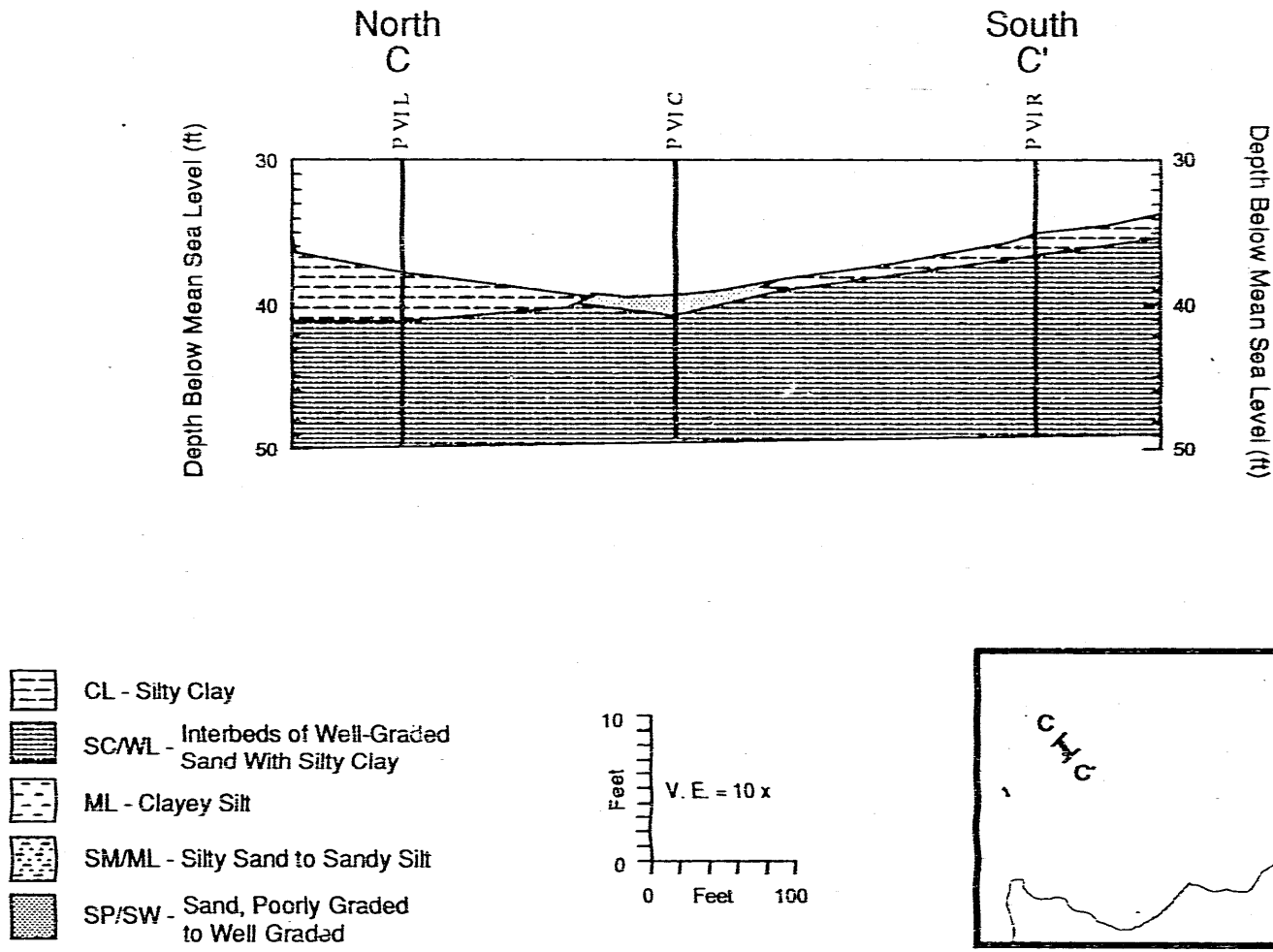


FIGURE 3.9. Sediment Lithology at Transect VI of Pinole Shoal Reach, John F. Baldwin Ship Channel, San Pablo Bay, California

deposit is probably between 10,000-12,000 years B.P.; no discontinuities were noted in the YBM unit, so it can be assumed that no other units were penetrated.

Sediment colors ranged from dark olive gray to dark gray to black, with no obvious pattern of distribution. Many of the cores displayed a color change from very dark gray in the upper section to black in the lower section. A total of 10 cores from Pinole Shoal exhibited noticeable odors. The upper 3 ft of sediment from Stations P VI L, P VII L, P IX.5 L, and P XIV C smelled of petroleum products, while hydrogen sulfide odor was detected in the upper 3 ft at Stations P I C, P V R, P V C, P VII C, P X R, and P XII B2. No trends are obvious in these cores because of their widely distributed nature. Darker soil colors are commonly associated with the sulfide odors and concentration of organic matter, suggesting the presence of a chemically reducing environment.

3.2.3 Carquinez Strait

Nine cores, ranging from 3.8 to 11.6 ft in length, were characterized for the Carquinez Strait reach of John F. Baldwin Ship Channel. The only unit penetrated was the YBM. Figures 3.10 through 3.12 are cross sectional interpretations based on geologic logs from these cores. Sediment movement through Carquinez Strait is greatly affected by tidal currents; sediments are transported through the strait as bedload and suspended load to San Pablo Bay (USACE 1975a). Another depositional factor in Carquinez Strait is freshwater inflow from winter storm runoff; freshwater inflow mixes with saline water in the bay to create horizontal and vertical density-salinity currents. Because these currents are density driven, they are most competent in transporting sediments in the deeper portions of the channels (USACE 1975a). Central channel cores exhibit well to poorly graded sand lenses with a maximum particle size of medium sand, while channel margin cores are massive to thinly laminated deposits of silt and clay. Such a pattern would be anticipated because of higher current velocities in the central channel axis relative to areas of comparatively low energy located along the channel edges. Silt and clay rip-up clasts within a matrix of poorly graded sand in cores from Station C II C indicate currents are strong enough to scour and transport relatively undisturbed bottom sediments from the channel margins and redeposit them within the

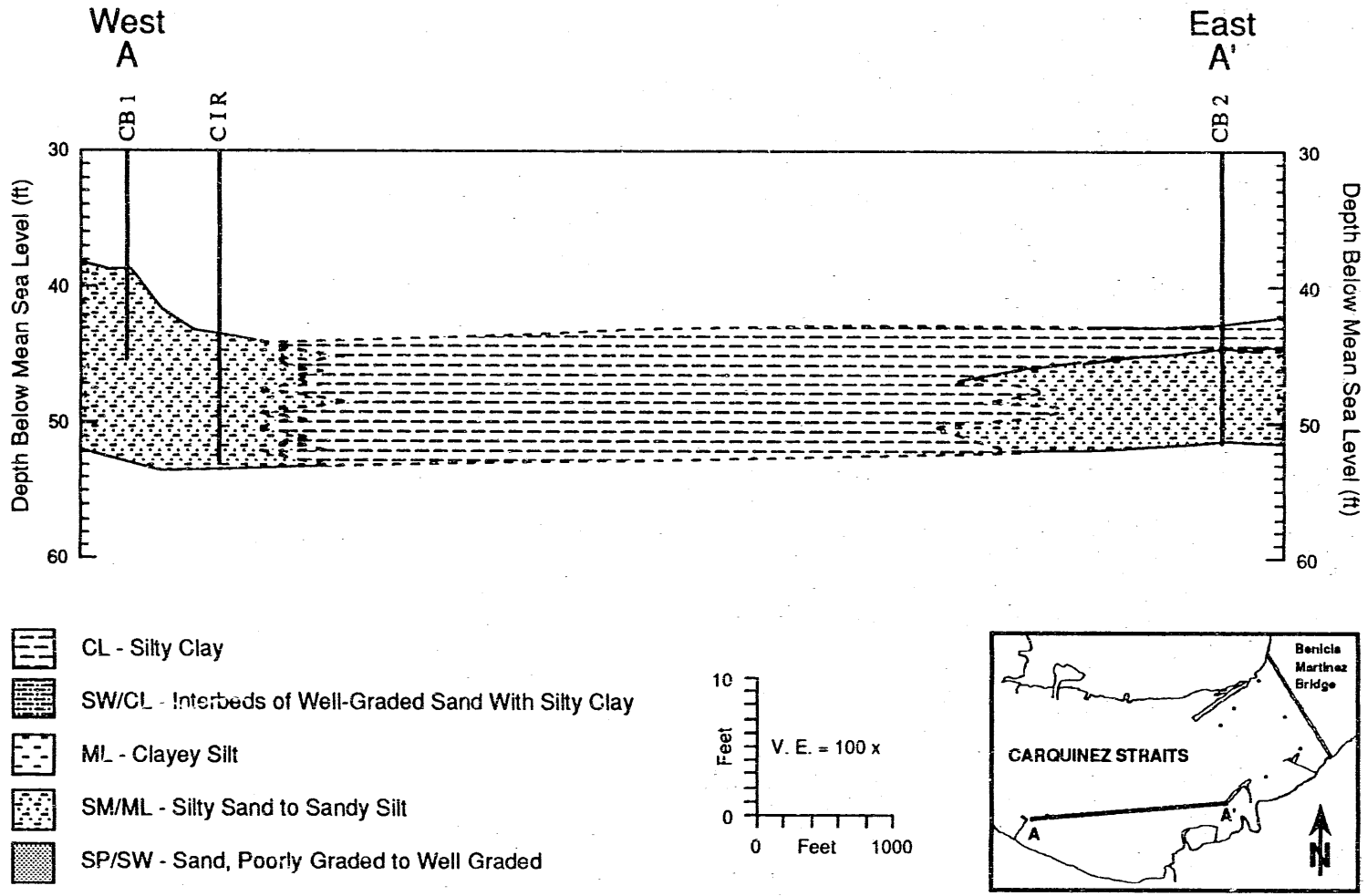


FIGURE 3.10. Sediment Lithology Along the Southern Edge of the Carquinez Strait Reach of the John F. Baldwin Ship Channel

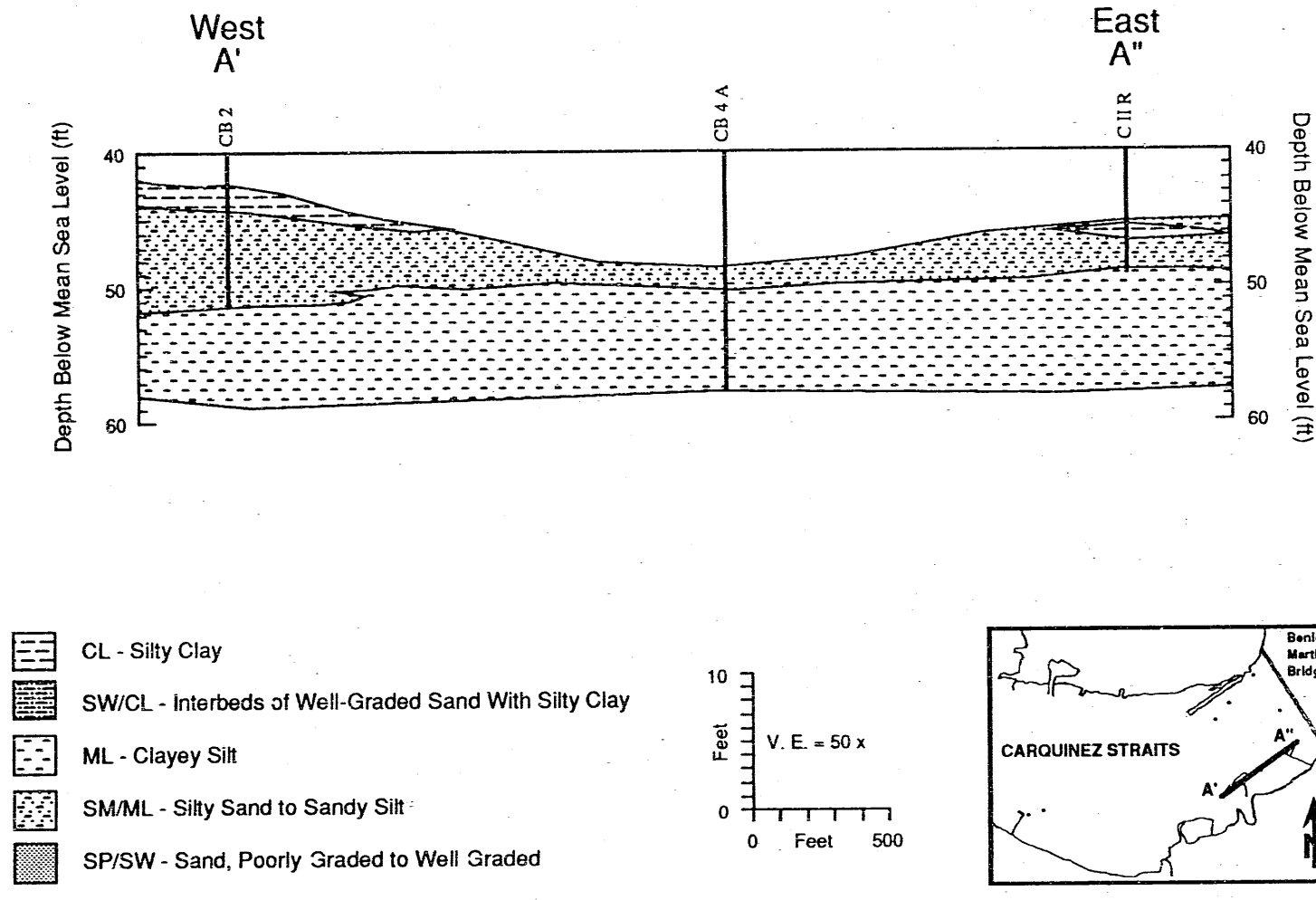


FIGURE 3.11. Sediment Lithology Along the Carquinez Strait Reach of John F. Baldwin Ship Channel, Southwest of the Benicia-Martinez Bridge

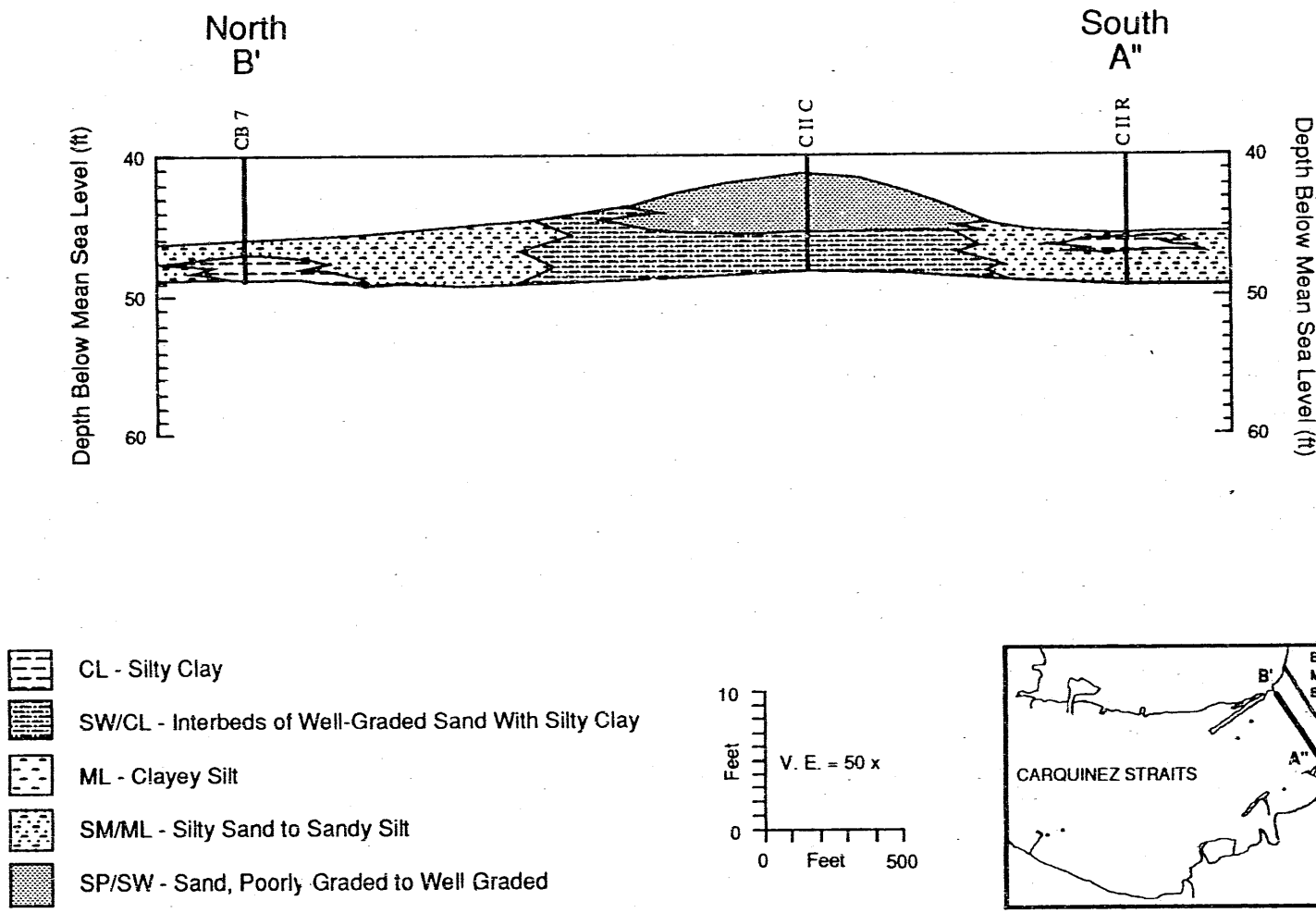


FIGURE 3.12. Sediment Lithology Across the Carquinez Strait Reach of John F Baldwin Ship Channel, Adjacent to the West Side of the Benicia-Martinez Bridge

channel bottom. Petroleum odors were noted in the rip-up clasts as well as in alternating sand and clay layers in several cores. Depth of the petroleum odor varies from 0.5 to 4 ft below mudline and is commonly associated with a change in sediment color.

Organic-rich accumulations were present in cores from Stations C II C, CB 6 and CB 7; these accumulations consisted primarily of small twigs and rootlets presumably introduced during storm runoff. Sediment colors ranged from shades of olive gray to dark gray to black, with no distinct trends throughout the sample area.

3.3 CHEMICAL ANALYSIS OF SEDIMENTS

This section presents the results of chemical analyses performed on sediment samples from the John F. Baldwin Ship Channel. Sediment samples were prepared from cores as described in Section 2.2 and analyzed according to the methods in Section 2.3. For each parameter, the quality control data are summarized to establish acceptability of the results that follow.

3.3.1 Grain Size and Total Organic Carbon)

3.3.1.1 Quality Control Summary

The QC data for analysis of grain size and TOC is presented in Appendix D, Tables D.1 and D.2. Grain size QC limitations have not been established and standardized. However, the following evaluations are provided to allow consideration of relative precision and accuracy of grain-size measurements in a way that is comparable to the standardized QC procedures used in chemical analyses. The grain size QC data show that the relative percent difference (RPD) between compositing duplicates related to the grain size samples ranged from 0 to 63%. Only the set of compositing duplicates from Station P XIII B2 2-7.5 did not compare well (RPDs were above our provisional limit of 25%). This is probably an expression of composite heterogeneity rather than a measure of analytical precision, because the samples were not from the same sample jar. Because the other six duplicates were within our provisional limit, these data qualified as acceptable.

Quality control data for TOC (Appendix D, Table D.1) show that the RPD ranged from 2 to 96% for the seven compositing duplicates (two samples from

one composite). Two stations had RPDs above 25% (60% for WR IV R and 96% for P IV.5 L). The low consistency of measurement may be related to the low TOC values (< 0.5%) and sample heterogeneity resulting from the presence of wood fiber material. This result should not indicate a cause for concern over analytical precision, as the RPD data presented at the end of Table D.1 for analytical duplicates (two aliquots from the same sample jar) show a range of 0-6.5%, well below the acceptable maximum of 25%. Analysis of SRM MESS-1 resulted in a value of 2.33% TOC, which is within 5% of the values found for this SRM during other USACE studies (Brown et al. 1989; Word et al. 1990a,b).

3.3.1.2 Grain Size and TOC Results

Sediment grain size and TOC results are summarized in Table 3.2, while the complete data set for grain size is presented in Appendix C, Table C.1. Expressed as percent sand, sediment grain size was highly correlated to TOC in the majority of samples from the John F. Baldwin Ship Channel (Figure 3.13). This relationship breaks down in Carquinez Strait and at the northeastern end of the Pinole Shoal at the junction between Carquinez Strait and San Pablo Bay. Three samples from this area had a higher concentration of organic carbon for a given percent sand compared with the majority of samples. These included Stations C II C 4-6.8, CB 6 0-6.5, and CB 7 0-3.1 (Figure 3.13). This difference in correlation may indicate that these three more eastern Carquinez Strait samples had a different source of TOC than did the other samples. The remaining 12 Carquinez Strait and eastern Pinole Shoal samples did not exhibit a correlation between percent sand and TOC, as sediment organic carbon levels were approximately 0.5%, while percent sand in these samples ranged from 10 to 40%.

The TOC concentrations from John F. Baldwin Ship Channel (Table 3.2) were compared with TOC in sediment from potential offshore disposal sites near Point Reyes. The Point Reyes sediment had TOC concentrations of 0.38 and 0.81% for coarse and fine sediments, respectively (Word et al. 1990b). Sediment from 9 of 11 West Richmond sites had TOC concentrations within this range. West Richmond TOC exceeded Point Reyes fine sediment TOC in the upper 6 ft at Stations WR V L and WR IV R, while no West Richmond TOC concentrations were less than those observed in Point Reyes coarse sediment.

TABLE 3.2. Total Organic Carbon and Grain Size Distribution of John F. Baldwin Ship Channel Sediments

Station, Section, ft		TOC, % dry wt.	% Gravel	% Sand	% Silt	% Clay
Detection Limits (DL)						
Target DL		0.10	N/A	N/A	N/A	N/A
Achieved DL		0.10	N/A	N/A	N/A	N/A
West Richmond						
WR VII C	0-5.5	0.53	1	67	16	16
WR VI L	0-4[a]	0.58	0	60	18	22
WR V L	0-6	1.05	1	40	27	32
WR IV.5 C	0-4	0.76	1	47	26	26
WR IV.5 C	4-8	0.75	2	61	21	16
WR IV R	0-6	0.92	0	31	32	37
WR IV R	6-11.5[b]	0.40	1	67	17	15
WR III L	0-6.6	0.46	2	76	12	10
WR III C	0-6.4	0.44	2	72	13	13
WR II L	0-6.9	0.49	3	73	14	10
WR I R	0-5.1	0.65	1	49	25	25
Pinole Shoal						
P I C	0-3	1.35	0	6	47	47
P II C	0-4.3	0.94	0	10	48	42
P III L	0-3	0.96	0	7	51	42
P IV R	0-8	0.81	0	34	37	29
P V L	0-8.4	0.97	0	15	42	43
P V C	0-8.7	0.95	0	13	48	39
P V R	0-5	0.80	0	25	37	38
P V R	5-10.5	0.86	0	21	46	33
P VI L	0-5	0.94	0	18	34	48
P VI L	5-11.6	0.79	0	19	48	33
P VI C	0-9	0.41	0	67	19	14
P VI R	0-5	0.55	1	54	20	25
P VI R	5-11.7	0.67	0	37	35	28
P VII C	0-5	0.65	0	51	23	26
P VII C	5-10.1	0.49	0	53	25	22
P VIII L	0-6.6	0.95	0	26	31	43
P VIII L	6.6-9.5	0.20	0	82	9	9
P VIII R	0-8	0.84	0	47	23	30
P VIII R	8-10.5	0.42	0	76	8	16
P VIII.5 C	0-3.6	0.22	0	87	7	6
P VIII.5 C	3.6-10.4[b]	0.33	0	69	19	12

TABLE 3.2. (contd)

Station, Section, ft		TOC, % dry wt.	% Gravel	% Sand	% Silt	% Clay
Pinole Shoal, contd						
P IX C	0-5	0.27	0	79	11	10
P IX C	5-11.8	0.19	0	82	10	8
P IX.5 L	0-5(b)	0.25	0	86	7	7
P IX.5 L	5-10.1	0.13	0	88	6	6
P X R	0-6	0.15	0	86	6	8
P X R	6-11.5	0.12	0	87	7	6
P X.5 C	0-5	0.18	1	86	7	6
P X.5 C	5-11	0.19	0	82	11	7
P XI L	0-3.5	0.37	1	62	18	19
P XII R	0-8.5	0.44	1	34	31	34
P XII RR	0-9.2	0.68	1	43	25	31
P XII B2	0-2	0.10	0	91	4	5
P XII B2	2-7.5(b)	0.57	0	16	41	43
P XII B2	7.5-12.5	0.36	0	63	20	17
P XII B1	0-5	1.42	1	21	31	47
P XII B1	5-11.1	0.76	1	36	27	36
P XII.5 C	0-6(b)	0.42	0	24	38	38
P XII.5 R	0-5.3	0.55	0	14	36	50
P XII.5 R	5.3-11.1	0.80	1	55	25	19
P XIII L	0-6(b)	0.41	0	19	40	41
P XIII R	0-5	0.37	0	18	41	41
P XIII R	5-10	0.48	0	16	42	42
P XIV C	0-4.5	0.71	0	55	21	24
Carquinez Strait						
CB 1	0-6.6	0.55	0	4	44	52
C I R	0-8(b)	0.43	0	4	51	45
CB 4 A	0-3.8	0.71	0	39	28	33
CB 4 A	3.8-11.4	0.49	0	5	43	52
CB 5	0-4	0.43	0	36	30	34
CB 6	0-6.5	1.44	4	61	22	13
CB 7	0-3.1	2.19	0	32	34	34
C II C	0-4	0.18	0	94	3	3
C II C	4-6.8	0.85	0	75	11	14
C II R	0-2.4	0.42	0	16	42	42

(a) TOC value is the mean of two internal (analytical) laboratory duplicates.
(b) TOC and grain-size values are the mean of two compositing duplicates.

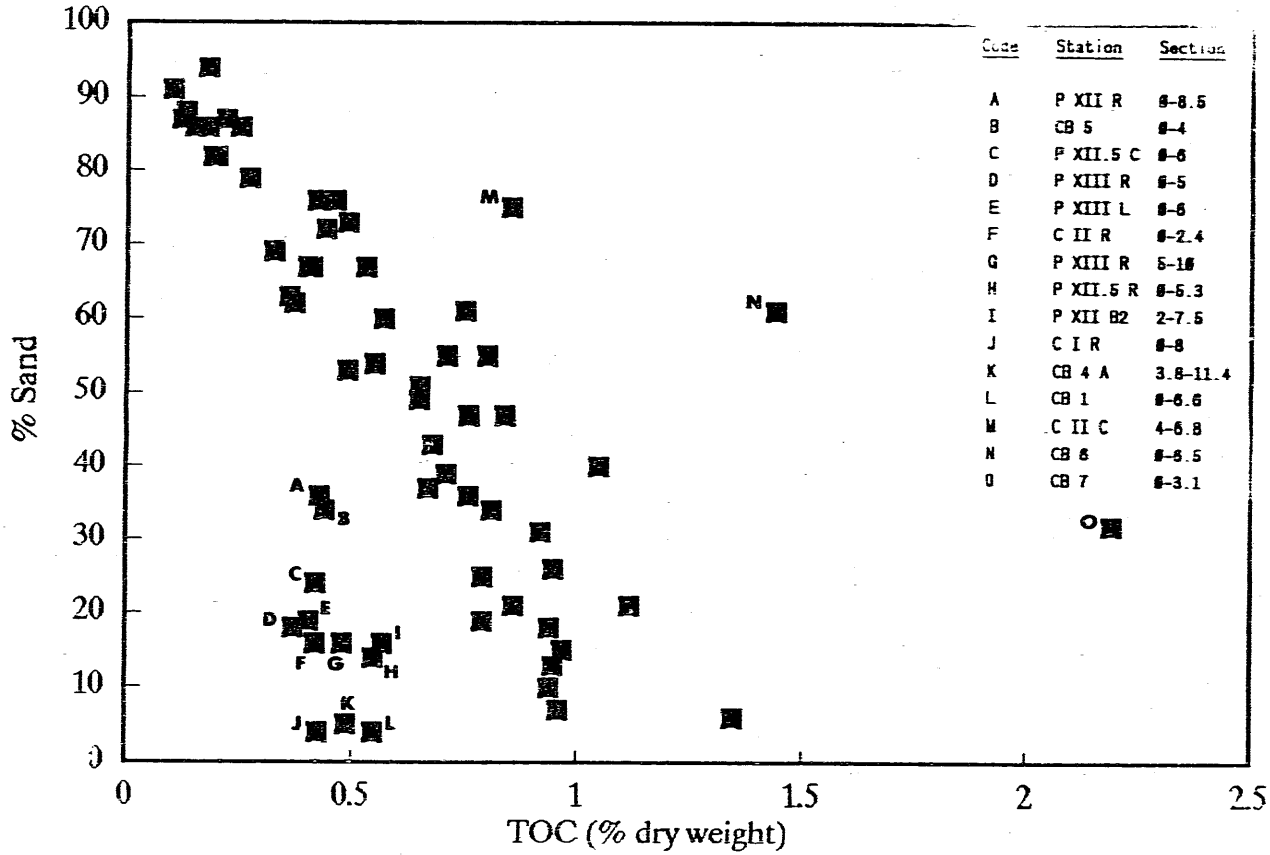


FIGURE 3.13. Relationship Between Total Organic Carbon and Grain Size (Expressed as Percent Sand) in John F. Baldwin Samples

In the Pinole Shoal area of San Pablo Bay, TOC concentrations were greatest in the southwestern portion of the channel (Stations P I through P VI) where the concentrations generally exceeded the values in fine-grained sediment at Point Reyes. The concentrations of TOC decreased and were generally intermediate between coarse- and fine-grained Point Reyes sediment in the central portion (Stations P VI through P VIII) of the channel. The composites from Stations P VIII.5 to P XI L had the lowest levels of TOC in the Pinole Shoal sampling area and were all less than observed in the coarse-grained material at Point Reyes. The levels of organic carbon generally increased toward the northeastern end of Pinole Shoal, where they were intermediate between Point Reyes fine and coarse values except in one sample. The TOC in the upper 5 ft at Station P XII B1 exceeded the level in Point Reyes fine sediment by approximately 40%.

The TOC concentrations in Carquinez Strait were less than the level of those in Point Reyes fine sediment except at Stations CB 6, CB 7, and the lower (4 - 6.8 ft) section of Station C II C, where they exceeded 0.8%. In the upper 4 ft at Station C II C, TOC was less than the observed value at the coarse-grained Point Reyes reference site.

3.3.2 Oil and Grease and Petroleum Hydrocarbons

3.3.2.1 Quality Control Summary

Quality control data for both oil and grease and petroleum hydrocarbons (PH) are presented in Table D.3 in Appendix D. Quality control data include method blank results, compositing duplicate results, analytical duplicate results, and the results of matrix spike analyses. The detection limit of 20 mg/kg (dry wt) was met for all samples.

Eight method blanks were analyzed for oil and grease. Table D.3 presents the results of these analyses. Oil and grease were measured above detection limits in all blank analyses at concentrations ranging from 2.6 to 15 mg/kg. No method blanks were analyzed for petroleum hydrocarbons.

Seven compositing duplicates were analyzed to assess the efficiency of sample compositing. Relative percent differences between the duplicates ranged from 0 to 55.6% for oil and grease and from 0 to 90.3% for PH. Five of the seven oil and grease duplicates agreed well (RPD < 25%), and six of the

seven PH duplicates agreed well. Four samples were duplicated at the laboratory to assess analytical precision. The RPDs ranged from 0 to 16.7% for oil and grease duplicates and from 18.2 to 82.4% for PH duplicates. Overall, the analytical precision was better for measurement of oil and grease compared with measurement of PH.

To assess accuracy, matrix spike evaluations were performed on four samples. Spike recoveries are presented at the end of Table D.3. In all cases, spike recoveries were within acceptable limits, and in almost all samples were greater than 20%. Spike recoveries for sediment from Station C I R (0-8 ft) were 43 and 50% for oil and grease and PH, respectively. In each case, the measurements of accuracy and precision using RPD values that were greater than 50% occurred in samples where the actual concentrations of oil and grease of PH were relatively low and generally less than the desired detection limit of 20 mg/kg. Therefore, the significance of these relatively high RPDs carries less importance than if they had also occurred at concentrations beyond target detection limits.

3.3.2.2 Oil and Grease and Petroleum Hydrocarbon Results

The results of oil and grease and petroleum hydrocarbon analyses are presented in Table 3.3. Oil and grease concentrations ranged from 5.5 to 178 mg/kg. On the average, concentrations found in sediments from Pinole Shoal were lower than concentrations found in sediment from West Richmond. High concentrations of oil and grease in the method blanks indicate that the lower levels measured (less than approximately 15 mg/kg) are most likely attributed to contamination associated with the method. Because these concentrations were less than our target detection limits, the significance of blank contamination at these levels is minor.

The PH concentrations were similar to, although somewhat lower than, those measured for oil and grease. Concentrations measured for PHs ranged from 3.5 to 131 mg/g. The PH fraction is reported in Table 3.3 as a percent of total oil and grease.

TABLE 3.3. Total Oil and Grease, Petroleum Hydrocarbons, and Petroleum Hydrocarbon Fraction of Total Oil and Grease in John F. Baldwin Ship Channel Sediment

Station, Section, ft		Oil & Grease, mg/kg dry wt	Petroleum Hydrocarbons, mg/kg dry wt	Petroleum Fraction, %
West Richmond				
WR VII C	0-5.5	37	27	73
WR VI L	0-4	73	55	75
WR V L	0-6	79	74	94
WR IV.5 C	0-4	82	70	85
WR IV.5 C	4-8	18	16	89
WR IV R	0-6	167	112	67
WR IV R	6-11.5[a]	38	19	51
WR III L	0-6.6	61	11	18
WR III C	0-6.4	26	12	46
WR II L	0-6.9	20	5.8	29
WR I R	0-5.1	91	49	54
Pinole Shoal				
P I C	0-3	44	21	48
P II C	0-4.3	39	25	64
P III L	0-3	45	24	53
P IV R	0-8	34	22	65
P V L	0-8.4	53	40	75
P V C	0-8.7	33	24	73
P V R	0-5	45	28	62
P V R	5-10.5	93	21	23
P VI L	0-5	114	50	44
P VI L	5-11.6	41	24	59
P VI C	0-9	21	8.5	40
P VI R	0-5	63	39	62
P VI R	5-11.7	25	11	44
P VII C	0-5	98	32	33
P VII C	5-10.1	48	12	25
P VIII L	0-6.6	136	65	48
P VIII L	6.6-9.5	17	6.7	39
P VIII R	0-8	83	52	63
P VIII R	8-10.5	30	7.6	25
P VIII.5 C	0-3.6	41	13	32
P VIII.5 C	3.6-10.4[a]	9.4	7	74
P IX C	0-5	9.1	6	66
P IX C	5-11.8	8.5	8.6	101
P IX.5 L	0-5[a]	16	13	78
P IX.5 L	5-10.1	7.3	5.5	75
P X R	0-6	15	11	73
P X R	6-11.5	5.5	3.5	64

TABLE 3.3. (contd)

Station, Section, ft		Oil & Grease, mg/kg dry wt	Petroleum Hydrocarbons, mg/kg dry wt	Petroleum Fraction, %
Pinole Shoal, contd				
P X.5 C	0-5	9.3	7	75
P X.5 C	5-11	12	7.6	63
P XI L	0-3.5	17	13	76
P XII R	0-8.5	19	9.1	48
P XII RR	0-9.2	45	33	73
P XII B2	0-2	17	15	88
P XII B2	2-7.5(a)	76	28	37
P XII B2	7.5-12.5	23	14	61
P XII B1	0-5	178	131	74
P XII B1	5-11.1	102	43	42
P XII.5 C	0-6(a)	15	8.7	58
P XII.5 R	0-5.3	21	14	67
P XII.5 R	5.3-11.1	24	15	63
P XIII L	0-6(a)	18	14	75
P XIII R	0-5	7.3	1	14
P XIII R	5-10	10	10	100
P XIV C	0-4.5	62	38	61
Carquinez Strait				
CB 1	0-6.6	61	32	52
C I R	0-8(a)	15	12	86
CB 4 A	0-3.8	111	59	53
CB 4 A	3.8-11.4	31	20	65
CB 5	0-4	33	23	70
CB 6	0-6.5	16	18	113
CB 7	0-3.1	104	62	60
C II C	0-4	9.1	14	154
C II C	4-6.8	55	52	95

(a) Reported concentration is the mean concentration of the compositing duplicates.

3.3.3 Metals

3.3.3.1 Quality Control Summary

Quality control data for metals analyses are contained in Appendix D, Tables D.4 and D.5. Achieved DLs are compared with the target DL in Table 3.4. The DL for metals measured by atomic absorption (Ag, Cd, Co, Hg, and Tl) was calculated as three times the standard deviation (sd) of the blank values. For the eight metals measured by XRF, DLs were calculated as twice the sd of background levels in a geological matrix. The background levels were obtained by processing SiO_2 and $CaCO_3$ samples under the same conditions as the test samples. Although target DLs were not always met, the achieved DLs were reasonable for the methods, and the analytes were usually present in far greater quantity than the achieved DL (Al, Co, and Cr). One exception was Tl, which was undetected in nine samples at four times the target DL. Another was Se, with many samples below detection at an achieved DL approximately eight times the target DL.

The method blanks associated with samples analyzed by atomic absorption (Ag, Cd, Co, Hg, Tl) were clean with the exception of the presence of Ag and Hg in some method blanks. The Ag occurred in one blank at the detection limit of 0.03 mg/kg dry wt. The Hg was present in blanks at concentrations of 0.20 mg/kg, because of the presence of Hg in the boric acid used during the sample processing (E. Crecelius, personal communication 1990). The Hg occurred in all blanks with little variation in concentration (sd = 0.01), and was corrected for when measuring Hg in samples. Further justification for Hg blank compensation is provided by the accurate measurements of Hg in SRMs 1646 and MESS-1.

The results of analysis of SRMs 1646 and MESS-1 showed that actual values were generally within specified ranges except for Al, Cr, and Ni, which were in most cases 5-15% higher than certified values (Appendix D, Table D.4). This difference can probably be attributed to the XRF technique used to analyze the samples, while the SRM certification was performed by a variety of techniques that did not always include XRF. The XRF technique is able to detect more of the matrix metal contribution than analysis requiring sediment digestion.

TABLE 3.4. Metals in John F. Baldwin Ship Channel Sediments (< = not detected above given detection limit)

Station, Section, ft		Concentration (mg/kg dry wt except Al)												
		Ag	Al (%)	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Shale soil(a)		0.10	8.0	6.6	0.30	20	100	57.0	0.4	95	20.0	0.60	1	80
Point Reyes coarse[b]		0.04	NA	6.9	1.67	NA	315	9.8	0.09	42	7.7	0.31	0.44	36
Point Reyes fine [c]		0.04	NA	7.2	0.63	NA	341	12.3	0.07	51	7.5	0.34	0.34	55
Detection Limits														
Target DL		0.1	0.001	2	0.1	0.1	2	2	0.02	2	2	0.1	0.1	2
Lowest achieved DL		0.03	0.83	1.0	0.01	0.67	9	1	0.02	2	1.9	0.42	0.27	0.9
Maximum achieved DL		0.03	0.83	1.0	0.01	0.67	9	1	0.02	2	1.9	0.89	0.42	0.9
West Richmond														
WR VII C	0-5.5	0.07	6.09	9.0	0.17	14.3	210	25.4	0.16	68	16.5	0.66	<0.42	73
WR VI L	0-4	0.11	6.53	11.6	0.22	15.6	197	28.9	0.26	73	13.3	<0.58	0.48	82
WR V L	0-6	0.24	6.89	11.5	0.33	17.4	207	41.3	0.25	87	28.1	<0.62	<0.42	114
WR IV.5 C	0-4	0.22	7.47	10.6	0.25	17.7	236	41.6	0.28	90	26.1	<0.61	<0.42	111
WR IV.5 C	4-8	0.04	6.58	14.4	0.17	19.6	171	24.6	0.07	87	7.6	<0.61	<0.42	69
WR IV R	0-6	0.36	7.45	12.3	0.30	15.2	226	48.5	0.38	102	32.3	<0.86	0.46	127
WR IV R	6-11.5[d]	0.09	6.93	10.9	0.14	17.6	225	24.9	0.08	95	10.4	<0.87	0.47	78
WR III L	0-6.6	0.05	7.27	8.9	0.10	17.6	205	23.8	0.02	94	7.2	<0.85	0.62	74
WR III C	0-6.4	0.04	6.02	10.3	0.12	16.6	220	24.1	0.02	93	7.7	<0.85	0.46	71
WR II L	0-6.9	0.04	5.86	8.7	0.10	16.6	208	22.1	0.25	91	5.6	<0.88	0.61	74
WR I R	0-5.1	0.19	7.38	9.4	0.23	17.9	375	38.0	0.20	98	23.8	<0.86	0.46	106
Pinole Shoal														
P I C	0-3	0.08	7.06	10.9	0.18	16.1	191	39.0	0.06	105	9.6	<0.85	0.46	96
P II C	0-4.3	0.09	7.70	11.2	0.19	11.1	179	45.0	0.05	108	8.3	<0.84	0.61	104
P III L	0-3	0.09	7.69	9.6	0.20	10.7	206	47.3	0.06	113	8.8	0.88	0.46	100
P IV R	0-8	0.08	7.09	8.4	0.17	11.3	253	33.7	0.06	103	8.9	<0.86	0.77	90

TABLE 3.4. (contd)

Station, Section, ft		Concentration (mg/kg dry wt except Al)												
		Ag	Al (%)	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Pinole Shoal, contd														
P V L	0-8.4	0.16	8.48	10.0	0.27	12.1	237	56.1	0.16	117	17.1	<0.52	0.62	119
P V C	0-8.7	0.09	8.08	8.4	0.22	13.0	218	49.1	0.06	123	11.9	<0.52	0.47	102
P V R	0-5	0.12	8.15	13.2	0.25	12.5	247	58.8	0.18	124	13.1	<0.52	0.62	118
P V R	5-10.5	0.10	8.12	10.0	0.18	11.8	249	43.5	0.06	113	8.4	0.62	0.46	100
P VI L	0-5	0.27	8.70	17.0	0.48	15.4	278	77.7	0.38	146	28.5	<0.51	0.62	162
P VI L	5-11.6	0.10	8.06	8.6	0.18	12.3	207	48.0	0.06	117	9.7	<0.50	0.60	102
P VI C	0-9	0.08	7.14	8.5	0.13	13.4	239	31.3	0.02	105	10.4	<0.51	0.77	82
P VI R	0-5	0.15	7.80	10.4	0.22	13.8	256	44.8	0.14	116	18.2	<0.50	0.61	115
P VI R	5-11.7	0.08	8.48	9.6	0.16	13.6	239	44.0	0.05	112	7.8	<0.52	0.77	98
P VII C	0-5	0.12	7.36	12.0	0.23	14.2	267	47.4	0.16	113	15.7	<0.51	0.61	106
P VII C	5-10.1	0.07	7.42	9.4	0.15	14.6	210	36.6	0.03	106	7.9	<0.51	0.46	88
P VIII L	0-6.6	0.24	8.74	13.9	0.32	18.2	213	65.3	0.24	129	26.6	<0.86	0.77	140
P VIII L	6.6-9.5	0.04	7.09	8.6	0.09	18.5	281	25.6	0.03	98	9.3	<0.85	0.46	70
P VIII R	0-8	0.18	9.22	14.1	0.31	16.5	273	60.3	0.19	134	18.7	<0.88	0.62	133
P VIII R	8-10.5	0.06	6.74	18.7	0.13	15.5	242	30.8	0.03	97	8.2	<0.51	0.46	79
P VIII.5 C	0-3.6	0.05	6.58	12.1	0.10	18.0	248	24.0	0.04	100	13.5	<0.89	0.31	80
P VIII.5 C	3.6-10.4[d]	0.06	7.30	8.8	0.12	15.8	267	34.0	0.04	106	8.0	<0.86	0.54	84
P IX C	0-5	0.05	6.11	12.0	0.09	18.8	288	25.1	0.02	96	8.6	<0.85	0.62	75
P IX C	5-11.8	0.04	7.31	11.7	0.08	17.4	270	23.5	0.02	104	7.2	<0.88	0.31	71
P IX.5 L	0-5[d]	0.06	6.57	9.6	0.10	17.7	311	23.9	0.06	96	13.6	<0.86	0.39	75
P IX.5 L	5-10.1	0.04	7.61	8.1	0.08	19.9	276	21.9	0.02	105	9.5	<0.84	0.61	68
P X R	0-6	0.05	7.12	9.4	0.11	18.3	312	24.8	0.05	105	11.1	<0.84	0.62	83
P X R	6-11.5	0.04	7.36	13.2	0.08	18.9	393	25.6	0.02	113	8.2	<0.83	0.31	72
P X.5 C	0-5	0.07	7.16	12.4	0.09	18.3	313	23.8	0.03	99	9.2	<0.41	0.62	76
P X.5 C	5-11	0.04	6.85	9.9	0.09	18.2	333	29.3	0.03	99	7.2	<0.81	0.31	71
P XI L	0-3.5	0.14	8.13	10.2	0.17	18.7	345	39.7	0.10	112	10.2	<0.42	0.46	96
P XII R	0-8.5	0.05	9.06	14.3	0.13	17.2	331	46.5	0.26	108	11.8	<0.42	0.77	90
P XII RR	0-9.2	0.12	8.68	13.5	0.22	17.5	280	55.8	0.24	114	13.2	<0.41	0.31	115

TABLE 3.4. (contd)

Station, Section, ft		Concentration (mg/kg dry wt except Al)												
		Ag	Al (%)	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Pinole Shoal, contd														
P XII B2	0-2	0.04	6.21	8.6	0.10	18.2	307	21.0	0.06	91	16.4	<0.86	0.31	83
P XII B2	2-7.5[d]	0.11	9.30	17.1	0.15	19.3	284	58.5	0.32	106	14.3	0.93	0.54	89
P XII B2	7.5-12.5	0.08	8.26	8.2	0.13	21.4	561	38.7	0.06	114	7.7	<0.86	0.62	92
P XII B1	0-5	0.23	8.86	14.0	0.43	22.9	247	75.0	0.24	122	24.0	<0.85	0.62	152
P XII B1	5-11.1	(e)	7.53	12.6	0.26	20.8	377	51.6	0.13	110	12.9	1.02	0.31	113
P XII.5 C	0-6[d]	0.08	9.35	16.9	0.19	16.4	242	53.9	0.37	97	16.4	<0.41	0.46	95
P XII.5 R	0-5.3	0.08	10.31	14.6	0.15	18.5	241	60.8	0.33	106	15.9	0.42	0.62	92
P XII.5 R	5.3-11.1	0.07	8.67	9.6	0.14	19.3	435	39.9	0.05	107	7.8	<0.41	0.61	93
P XIII L	0-6[d]	0.09	10.19	17.1	0.19	17.9	189	53.5	0.30	86	16.3	0.58	0.62	92
P XIII R	0-5	0.08	9.62	17.4	0.16	15.7	195	52.3	0.29	76	13.6	<0.42	0.61	88
P XIII R	5-10	0.08	9.50	18.8	0.16	17.1	207	55.0	0.37	95	12.2	<0.39	0.77	88
P XIV C	0-4.5	0.26	8.54	17.2	0.46	20.5	275	55.8	0.30	104	61.9	<0.63	0.31	136
Carquinez Strait														
CB 1	0-6.6	0.14	10.07	19.1	0.24	19.2	243	60.3	0.41	93	24.8	<0.83	0.77	102
C I R	0-8[d]	0.26	10.22	18.8	0.22	18.8	184	56.5	0.38	90	22.0	<0.60	0.69	102
CB 4 A	0-3.8	0.16	7.52	17.8	0.28	20.5	269	56.2	0.27	103	22.1	0.85	0.46	126
CB 4 A	3.8-11.4	0.09	9.75	19.1	0.15	20.6	230	67.3	0.38	120	15.0	<0.87	0.61	101
CB 5	0-4	0.05	7.59	9.9	0.15	19.8	204	29.4	0.13	89	14.7	<0.60	<0.42	88
CB 6	0-6.5	0.22	8.83	14.7	0.57	20.5	223	66.5	0.44	108	34.8	<0.59	<0.42	147
CB 7	0-3.1	0.27	8.00	14.1	0.36	19.2	206	61.7	0.22	108	24.9	0.96	0.62	132
C II C	0-4	0.03	6.16	8.4	0.09	18.2	190	17.6	0.06	81	10.4	<0.59	<0.42	71
C II C	4-6.8	0.07	7.26	16.4	0.34	20.6	249	33.1	0.18	99	17.5	<0.60	<0.42	104
C II R	0-2.4	0.06	11.21	21.4	0.19	19.4	164	54.2	0.45	80	13.6	<0.59	<0.42	84

(a) Krauskopf (1967).

(b) Mean of values reported by Word et al. (1988, 1990a,b).

(c) Mean of values reported by Word et al. (1989b) and Word et al. (1990a,b).

(d) Reported concentration is the mean concentration of compositing duplicate samples.

(e) Sample currently being reanalyzed.

Matrix spike recoveries were determined for three metals, Ag, Co, and Tl, in seven sediment samples to determine the accuracy of atomic absorption analyses (Appendix D, Table D.5). Only two matrix spike recoveries were outside QC limits of 75-125%; in Station C I R, 44% of the Ag spike was recovered, and in CB 4A, 71% of the Tl spike was recovered. Because all other spike recoveries for those metals were acceptable, these low recoveries probably indicate sample matrix interferences rather than analytical inaccuracy. Overall, QC analysis indicates that the metals data are acceptable.

3.3.3.2 Metals Results

Thirteen metals were measured in John F. Baldwin Ship Channel sediments. The resulting concentrations are reported in Table 3.4 and in Appendix C, Table C.3. Because all these metals occur naturally in sediments, we have compared their measured concentrations to a typical shale sediment (Krauskopf 1967) and, where data are available, to concentrations measured at two potential offshore disposal sites near Point Reyes (Word et al. 1988, 1990a,b). Proportions of John F. Baldwin sample concentrations relative to shale sediment, Point Reyes coarse-grained sediment, and Point Reyes fine-grained sediment are tabulated in Appendix C, Tables C.4 through C.6.

Silver concentrations varied by a factor of ten-fold, from 0.04 to 0.36 mg/kg dry wt in the 65 John F. Baldwin Ship Channel samples (Table 3.4, Figure 3.14). Nearly all samples had Ag concentrations exceeding the Point Reyes sediment level of 0.04 mg/kg, while 24 samples showed concentrations greater than the average of 0.10 mg/kg for Ag in shale sediment (Krauskopf 1967). Two samples had Ag concentrations at least three times higher than typical shale values, one in West Richmond (WR IV R) and one in Carquinez Strait (C I R, rep 1). These values are approximately equal to the maximum levels seen in Richmond Harbor (Brown et al. 1989), but are only one third of the maximum levels observed in Oakland Harbor (Word et al. 1990b). The Carquinez Strait sample was one of two compositing duplicates; the second sample from the same composite had a concentration of 0.13 mg/kg, showing that distribution of Ag is heterogeneous in the sediment. Nine other stations, two in West Richmond, five in Pinole Shoal, and two in Carquinez Strait, had Ag concentrations that were greater than two- but less than three-fold the levels in typical shale soils.

Code	Station	Section
	West Richmond	
1	WR VII C	0-5.5
2	WR VI L	0-4
3	WR V L	0-6
4	WR IV.5 C	0-4
5	WR IV.5 C	4-8
6	WR IV R	0-6
7	WR IV R	6-11.5
7	WR IV R	6-11.5
8	WR III L	0-6.6
9	WR III C	0-6.4
10	WR II L	0-6.9
11	WR I R	0-5.1
	Pinole Shoal	
12	P I C	0-3
13	P II C	0-4.3
14	P III L	0-3
15	P IV R	0-8
16	P V L	0-8.4
17	P V C	0-8.7
18	P V R	0-5
19	P V R	5-10.5
20	P VI L	0-5
21	P VI L	5-11.6
22	P VI C	0-9
23	P VI R	0-5
24	P VI R	5-11.7
25	P VII C	0-5
26	P VII C	5-10.1
27	P VIII L	0-6.6
28	P VIII L	6.6-9.5
29	P VIII R	0-8
30	P VIII R	8-10.5
31	P VIII.5 C	0-3.6
32	P VIII.5 C	3.6-10.4
32	P VIII.5 C	3.6-10.4
33	P IX C	0-5
34	P IX C	5-11.8
35	P IX.5 L	0-5
35	P IX.5 L	0-5
36	P IX.5 L	5-10.1
37	P X R	0-6
38	P X R	6-11.5
39	P X.5 C	0-5
40	P X.5 C	5-11
41	P XI L	0-3.5
42	P XII R	0-8.5
43	P XII RR	0-9.2
44	P XII B2	0-2
45	P XII B2	2-7.5
45	P XII B2	2-7.5
46	P XII B2	7.5-12.5
47	P XII B1	0-5
48	P XII B1	5-11.1
49	P XII.5 C	0-6
49	P XII.5 C	0-6
50	P XII.5 R	0-5.3
51	P XII.5 R	5.3-11.1
52	P XIII L	0-6
52	P XIII L	0-6
53	P XIII R	0-5
54	P XIII R	5-10
59	P XIV C	0-4.5
	Carquinez Strait	
60	CB 1	0-6.6
61	C I R	0-8
61	C I R	0-8
63	CB 4 A	0-3.8
64	CB 4 A	3.8-11.4
65	CB 5	0-4
66	CB 6	0-6.5
67	CB 7	0-3.1
68	C II C	0-4
69	C II C	4-6.8
70	C II R	0-2.4

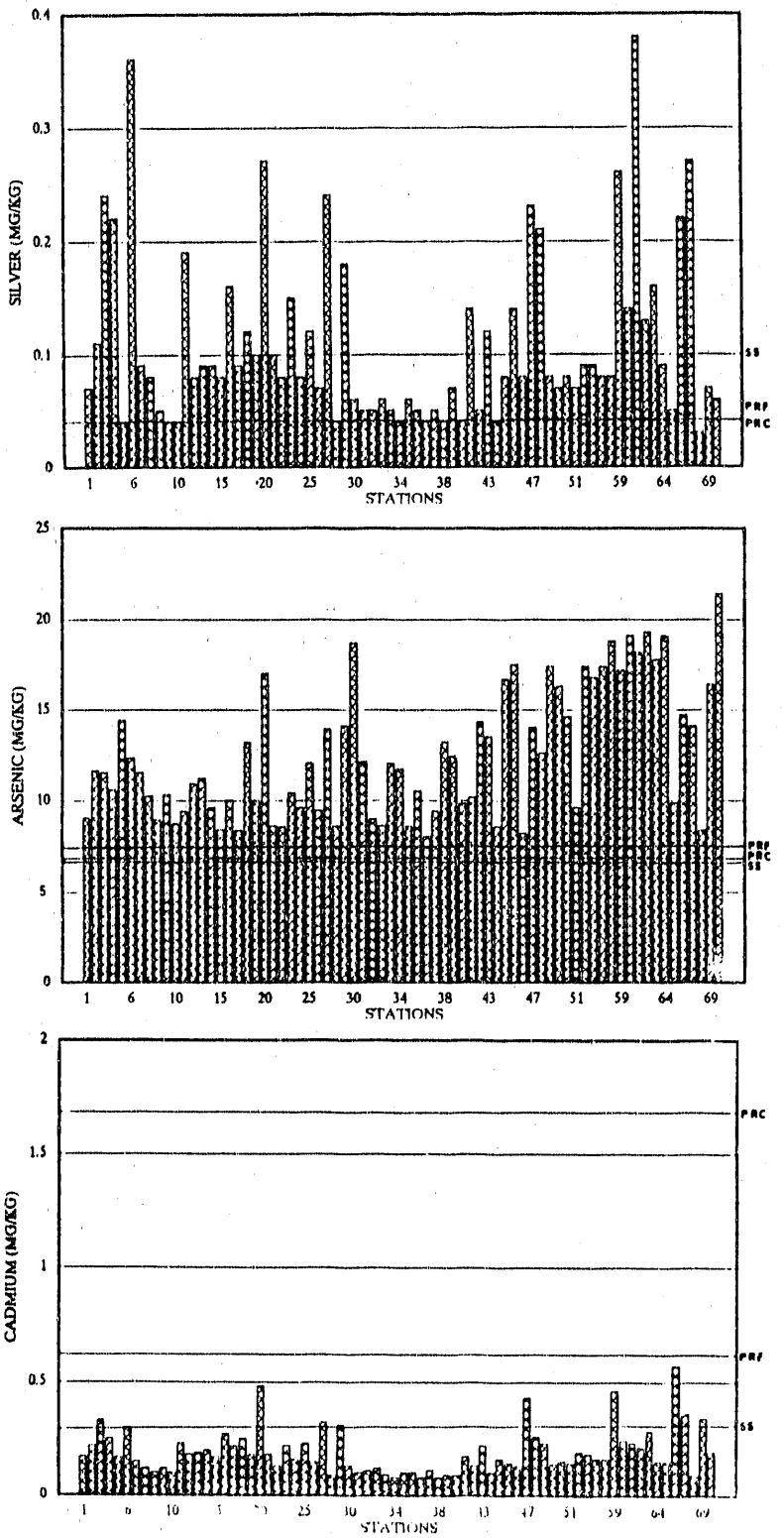


FIGURE 3.14. Concentrations of Silver, Arsenic, and Cadmium in John F. Baldwin Samples (SS=Shale Soil Concentration; PRC=Point Reyes Coarse Sediment Concentration; PRF=Point Reyes Fine Sediment Concentration)

Arsenic concentrations in sediment from the John F. Baldwin Ship Channel varied from 8.1 to 21.4 mg/kg dry wt (Table 3.4). For comparison, As concentrations in the fine- and coarse-grained sediment near Point Reyes are approximately 7 mg/kg, and the average worldwide shale sediment concentration is 6.6 mg/kg (Table 3.4). All John F. Baldwin Ship Channel samples exceeded the average worldwide shale concentration by at least 20%, while Point Reyes concentrations were exceeded by 15 to 300%. This comparison is shown graphically in Figure 3.14. The consistently elevated As concentration in San Francisco Bay and its offshore areas indicates natural sources for elevated As levels. The source of the elevated As levels may be associated with the freshwater inflow from the San Joaquin, Napa, and Sacramento rivers. This supposition is based on the observation that As concentrations were more consistently elevated (twice or more greater than Point Reyes) in samples from this area than in samples from West Richmond and western Pinole Shoal.

Cadmium concentrations in the John F. Baldwin Ship Channel area ranged from 0.08 to 0.57 mg/kg dry wt (Table 3.4). In comparison, Cd concentrations at the Point Reyes reference sites were much higher, ranging from 1.0 to 1.7 mg/kg dry wt, which is approximately three to six times the average worldwide concentration of 0.3 mg/kg dry wt found in shale sediment (Krauskopf 1967). Nine John F. Baldwin Ship Channel samples had Cd concentrations that exceeded the average shale concentration, but no samples had levels higher than those observed at the Point Reyes reference sites (Figure 3.14). One station that exceeded the average shale concentration was from the West Richmond area (WR V L), five were from Pinole Shoal (P VI L, P VIII L, P VIII R, P XII B1, and P XIV C), and three from the Carquinez Strait area (CB 6, CB 7, and C II C). For the John F. Baldwin Ship Channel study area, the concentration of Cd in the sediment appeared to be significantly correlated to the concentration of TOC (Figure 3.15).

Aluminum concentrations in the John F. Baldwin Ship Channel varied from slightly less than 6% to slightly more than 11% dry wt (Table 3.4), bracketing the average shale soil concentration of 8% (Krauskopf 1967) as shown in Figure 3.16. Al levels in 27 samples exceeded the shale soil concentration. One station (C II R) had 40% more Al than normally seen in typical shale samples. Five other stations had 30% more Al than the average shale sediment. Two of

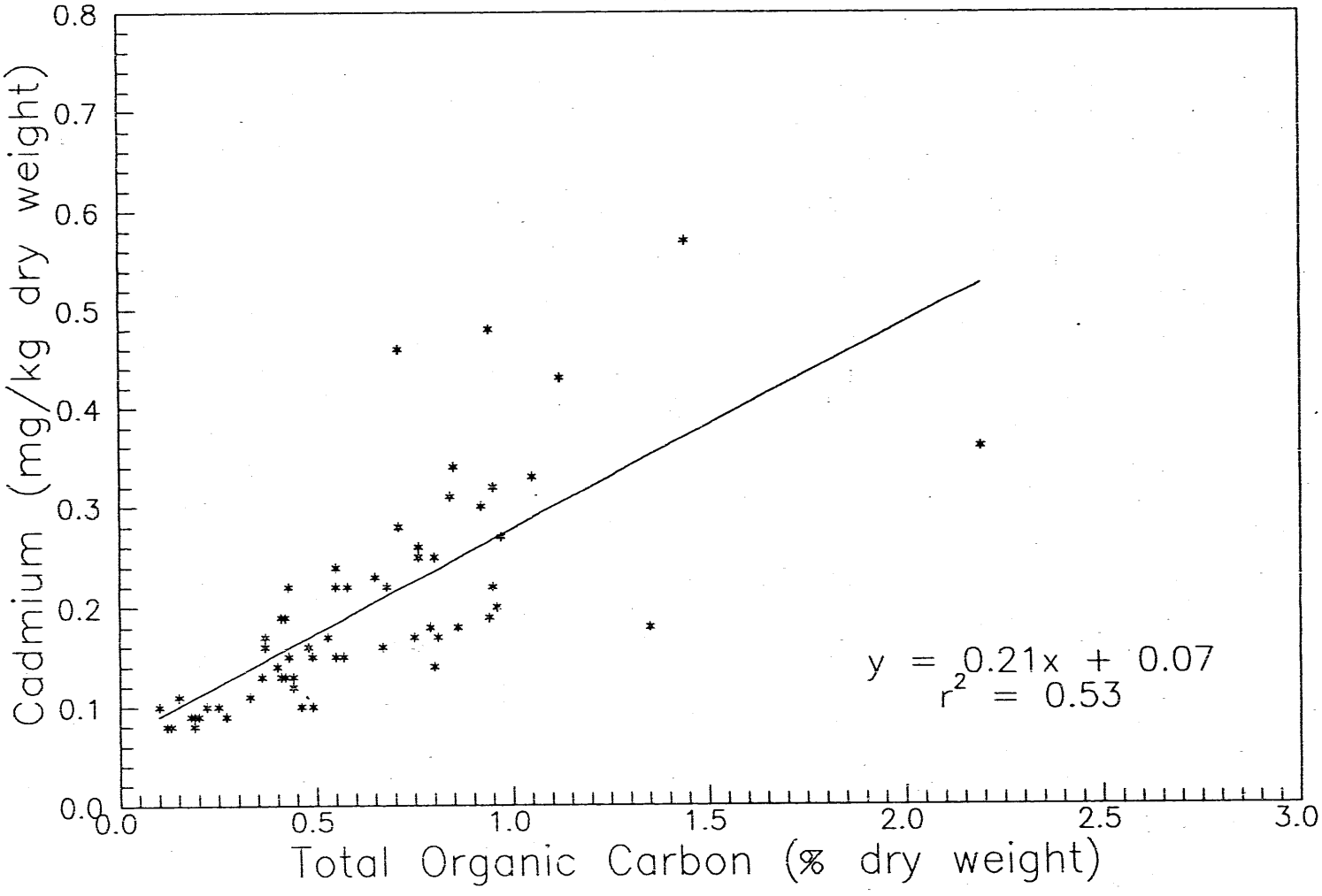


FIGURE 3.15. Relationship Between Total Organic Carbon and Cadmium Concentrations

these stations were located in Carquinez Strait (CB 1 and C I R) and three at the northeastern end of Pinole Shoal (P XII.5 R, P XIII L, and P XIII L). Aluminum was not measured in Point Reyes reference sediment during the studies of Word et al. (1988, 1990a,b), so Al concentrations in John F. Baldwin sediment could not be compared with those of Point Reyes sediment.

Cobalt concentrations in the John F. Baldwin Ship Channel area ranged from 10.7 to 22.9 mg/kg dry wt (Table 3.4). Cobalt concentrations in sediment from the Point Reyes reference areas have not been measured, but typical dry weight concentrations of Co in shale sediment averaged 20 mg/kg (Krauskopf 1967). Only eight sampling sites had concentrations of Co greater than the average shale content (Figure 3.16), with none exceeding the average by more than 15%. Cobalt concentrations do not appear to be different than natural levels observed in typical shale sediment.

Chromium concentrations in sediment from the John F. Baldwin Ship Channel ranged from 164 to 561 mg/kg dry wt and are thus all higher than the typical value of 100 mg/kg dry wt in shale sediment (Krauskopf 1967) (Table 3.3). Chromium values at the Point Reyes reference sites (315-341 mg/kg) were more than three times greater than the shale soil average, possibly indicating a natural source for Cr in the San Francisco Bay and offshore areas. Although most samples exceeded Cr levels in Richmond Harbor sediments (Brown et al. 1989), they did not approach the much higher levels found in Oakland Harbor's turning basin (Word et al. 1990b). Nine samples exceeded the Cr in Point Reyes coarse sediment (Figures 3.17). Only five of those exceeded the concentration of Cr at the Point Reyes fine-grained reference site (Figure 3.17). One of these stations is in the West Richmond reach (WR I R), while the remaining four are in the Pinole Shoal reach (P X R, P XII B2, P XII B1, and P XII.5 R).

The John F. Baldwin Ship Channel sediment copper concentrations ranged from 17.6 to 77.7 mg/kg dry wt (Table 3.4), a 4.4-fold variation. All these concentrations were higher than the range of Cu (10 - 12 mg/kg) at the Point Reyes reference stations, while only 12 were higher than the 57 mg/kg that is seen in typical shale sediment (Krauskopf 1967). Of these 12, 7 samples were from the Pinole Shoal area, and 5 were from Carquinez Strait (Figure 3.17).

Code	Station	Section
	West Richmond	
1	WR VII C	0-5.5
2	WR VI L	0-4
3	WR V L	0-6
4	WR IV.5 C	0-4
5	WR IV.5 C	4-8
6	WR IV R	0-6
7	WR IV R	6-11.5
7	WR IV R	6-11.5
8	WR III L	0-6.6
9	WR III C	0-6.4
10	WR II L	0-6.9
11	WR I R	0-5.1
	Pinole Shoal	
12	P I C	0-3
13	P II C	0-4.3
14	P III L	0-3
15	P IV R	0-8
16	P V L	0-8.4
17	P V C	0-8.7
18	P V R	0-5
19	P V R	5-10.5
20	P VI L	0-5
21	P VI L	5-11.6
22	P VI C	0-9
23	P VI R	0-5
24	P VI R	5-11.7
25	P VII C	0-5
26	P VII C	5-10.1
27	P VIII L	0-6.6
28	P VIII L	6.6-9.5
29	P VIII R	0-8
30	P VIII R	8-10.5
31	P VIII.5 C	0-3.6
32	P VIII.5 C	3.6-10.4
32	P VIII.5 C	3.6-10.4
33	P IX C	0-5
34	P IX C	5-11.8
35	P IX.5 L	0-5
35	P IX.5 L	0-5
36	P IX.5 L	5-10.1
37	P X R	0-6
38	P X R	6-11.5
39	P X.5 C	0-5
40	P X.5 C	5-11
41	P XI L	0-3.5
42	P XII R	0-8.5
43	P XII RR	0-9.2
44	P XII B2	0-2
45	P XII B2	2-7.5
45	P XII B2	2-7.5
46	P XII B2	7.5-12.5
47	P XII B1	0-5
48	P XII B1	5-11.1
49	P XII.5 C	0-6
49	P XII.5 C	0-6
50	P XII.5 R	0-5.3
51	P XII.5 R	5.3-11.1
52	P XIII L	0-6
52	P XIII L	0-6
53	P XIII R	0-5
54	P XIII R	5-10
59	P XIV C	0-4.5
	Carquinez Strait	
60	CB 1	0-6.6
61	C I R	0-8
61	C I R	0-8
63	CB 4 A	0-3.8
64	CB 4 A	3.8-11.4
65	CB 5	0-4
66	CB 6	0-6.5
67	CB 7	0-3.1
68	C II C	0-4
69	C II C	4-6 8
70	C II R	0-2 4

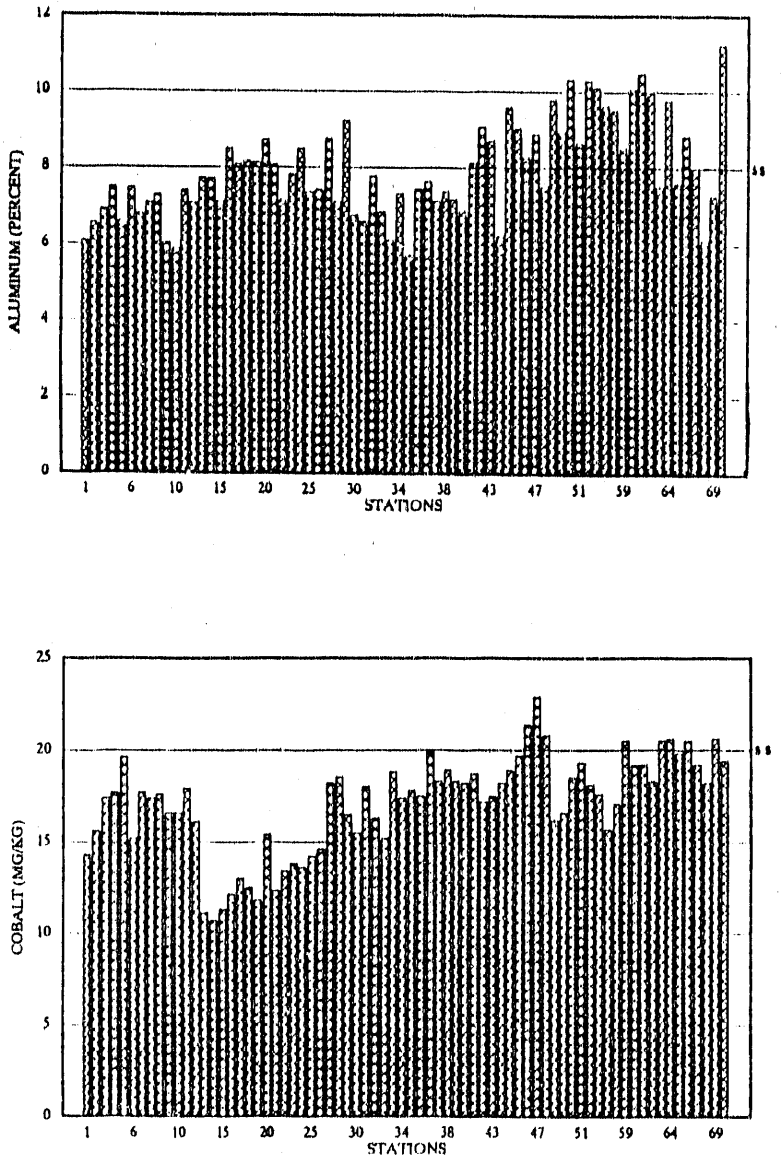


FIGURE 3.16. Concentrations of Aluminum and Cobalt in John F. Baldwin Samples (SS=Shale Soil Concentration; PRC= Point Reyes Coarse Sediment Concentration; PRF=Point Reyes Fine Sediment Concentration)

Code	Station	Section
West Richmond		
1	WR VII.C	0-5.5
2	WR VI L	0-4
3	WR V L	0-6
4	WR IV.5 C	0-4
5	WR IV.5 C	4-8
6	WR IV R	0-6
7	WR IV R	6-11.5
7	WR IV R	6-11.5
8	WR III L	0-6.6
9	WR III C	0-6.4
10	WR II L	0-6.9
11	WR I R	0-5.1
Pinole Shoal		
12	P I C	0-3
13	P II C	0-4.3
14	P III L	0-3
15	P IV R	0-8
16	P V L	0-8.4
17	P V C	0-8.7
18	P V R	0-5
19	P V R	5-10.5
20	P VI L	0-5
21	P VI L	5-11.6
22	P VI C	0-9
23	P VI R	0-5
24	P VI R	5-11.7
25	P VII C	0-5
26	P VII C	5-10.1
27	P VIII L	0-6.6
28	P VIII L	6.6-9.6
29	P VIII R	0-8
30	P VIII R	8-10.5
31	P VIII.5 C	0-3.6
32	P VIII.5 C	3.6-10.4
32	P VIII.5 C	3.6-10.4
33	P IX C	0-5
34	P IX C	5-11.8
35	P IX.5 L	0-5
35	P IX.5 L	0-5
36	P IX.5 L	5-10.1
37	P X R	0-6
38	P X R	6-11.5
39	P X.5 C	0-5
40	P X.5 C	5-11
41	P XI L	0-3.5
42	P XII R	0-8.5
43	P XII RR	0-9.2
44	P XII B2	0-2
45	P XII B2	2-7.5
45	P XII B2	2-7.5
46	P XII B2	7.5-12.5
47	P XII B1	0-5
48	P XII B1	5-11.1
49	P XII.5 C	0-6
49	P XII.5 C	0-6
50	P XII.5 R	0-5.3
51	P XII.5 R	5.3-11.1
52	P XIII L	0-6
52	P XIII L	0-6
53	P XIII R	0-5
54	P XIII R	5-10
59	P XIV C	0-4.5
Carquinez Strait		
60	CB 1	0-6.6
61	C I R	0-8
61	C I R	0-8
63	CB 4 A	0-3.8
64	CB 4 A	3.8-11.4
65	CB 5	0-4
66	CB 6	0-6.5
67	CB 7	0-3.1
68	C II C	0-4
69	C II C	4-6.8
70	C II R	0-2.4

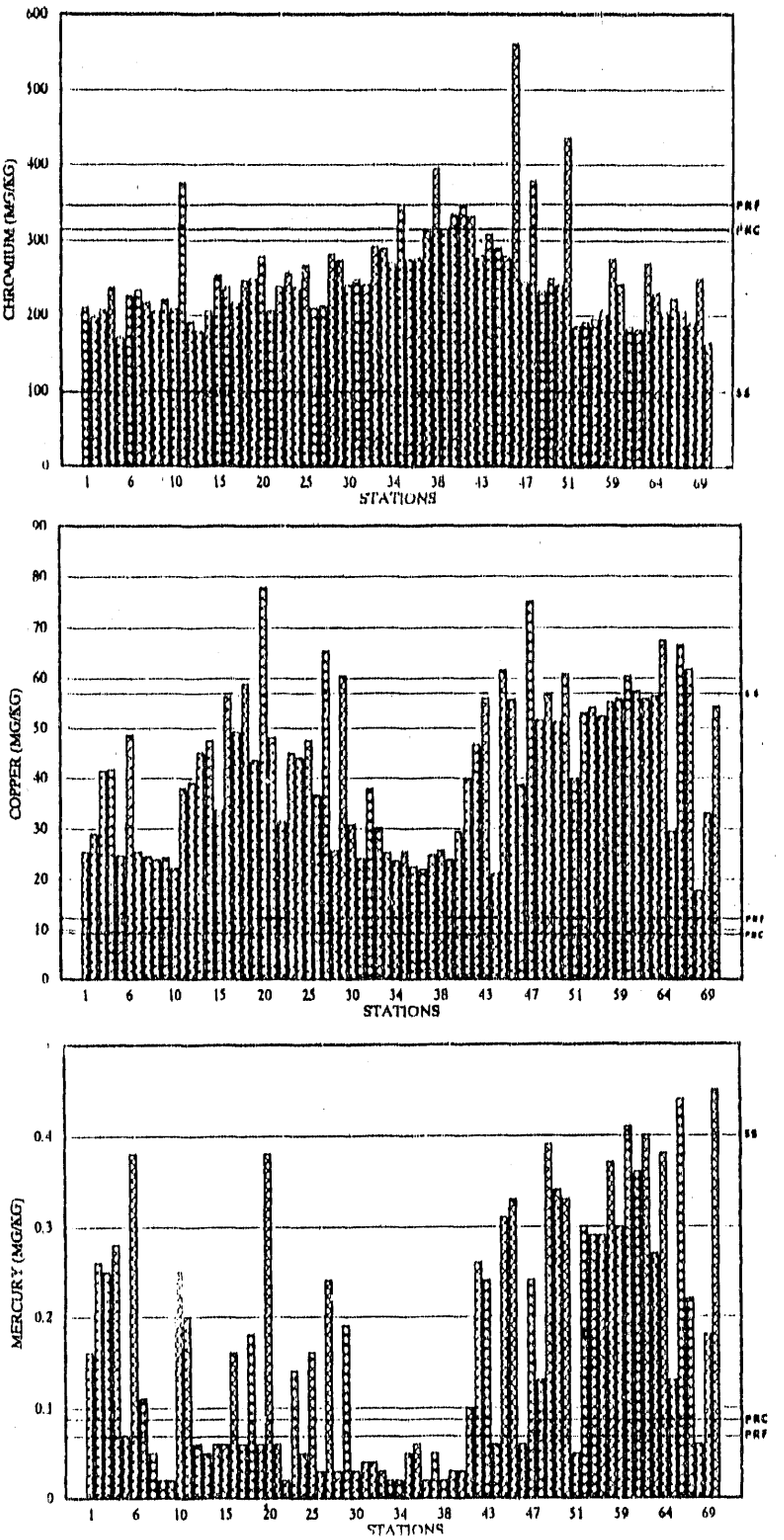


FIGURE 3.17. Concentrations of Chromium, Copper, and Mercury in John F. Baldwin Samples (SS=Shale Soil Concentration; PRC=Point Reyes Coarse Sediment Concentration; PRF=Point Reyes Fine Sediment Concentration

The John F. Baldwin Ship Channel stations showed a high variation in Hg concentrations, which ranged from 0.02 to 0.45 mg/kg dry wt (Table 3.4). Many of the John F. Baldwin Ship Channel samples (30 of 65) had Hg concentrations that were lower than the observed range of 0.07 to 0.09 mg/kg at the Point Reyes reference sites. However, half of these, or 15 samples, represent the deeper sediments (lower section of core) from the sampling sites, showing that surface sediments from 15 of the 48 stations had very low levels of Hg. In contrast, the average shale soil Hg concentration was 0.4 mg/kg, approximately five times higher than that of the Point Reyes reference sediment levels. All but three John F. Baldwin stations (in Carquinez Strait, Stations CB 1, CB 6, and C II R) had Hg concentrations less than the average shale concentration (Figure 3.17). Although the highest concentration of Hg in sediment of the John F. Baldwin Ship Channel was only 13% higher than the average shale content of Hg, the biological availability of this metal is unknown, especially in variable estuarine conditions such as those in San Francisco Bay.

Nickel concentrations in sediment from the John F. Baldwin Ship Channel ranged from 68 to 146 mg/kg dry wt (Table 3.4). All exceeded the observed range of 42-51 mg/kg Ni observed at the Point Reyes reference sites by Word et al. (1988, 1990a,b) as shown in Figure 3.18. Many stations also equaled or exceeded the average shale concentration of 95 mg/kg Ni (Krauskopf 1967). However, John F. Baldwin Ship Channel Ni concentrations are similar to or lower than those measured in other parts of San Francisco Bay (Brown et al. 1989; Word et al. 1988, 1990a,b).

Lead concentrations in sediment from the John F. Baldwin Ship Channel showed wide variation, ranging from 5.6 to 61.9 mg/kg dry wt (Table 3.4). Most of these sediments exceeded the 7.5 to 7.7 mg/kg range for Pb concentrations in the Point Reyes reference sites (Figure 3.18). Thirteen samples had Pb concentrations exceeding the average shale soil concentration of 20 mg/kg (Krauskopf 1967), four stations in West Richmond, four in Pinole Shoal, and five in Carquinez Strait. The highest Pb concentration (61.9 mg/kg) was found at Station P XIV C, located at the mouth of Carquinez Strait.

Selenium was detected in only nine John F. Baldwin Ship Channel sediment samples, at levels between 0.42 and 1.02 mg/kg dry wt (Table 3.4). In all

Code	Station	Section
	West Richmond	
1	WR VII C	0-6.6
2	WR VI L	0-4
3	WR V L	0-6
4	WR IV.5 C	0-4
5	WR IV.5 C	4-8
6	WR IV R	0-6
7	WR IV R	6-11.5
7	WR IV R	6-11.5
8	WR III L	0-6.6
9	WR III C	0-6.4
10	WR II L	0-6.9
11	WR I R	0-6.1
	Pinole Shoal	
12	P I C	0-3
13	P II C	0-4.3
14	P III L	0-3
15	P IV R	0-8
16	P V L	0-8.4
17	P V C	0-8.7
18	P V R	0-5
19	P V R	5-10.5
20	P VI L	0-5
21	P VI L	5-11.6
22	P VI C	0-9
23	P VI R	0-5
24	P VI R	5-11.7
25	P VII C	0-5
26	P VII C	5-10.1
27	P VIII L	0-6.6
28	P VIII L	6.6-9.5
29	P VIII R	0-6
30	P VIII R	6-10.5
31	P VIII.5 C	0-3.6
32	P VIII.5 C	3.6-10.4
32	P VIII.5 C	3.6-10.4
33	P IX C	0-5
34	P IX C	5-11.8
35	P IX.5 L	0-5
36	P IX.5 L	0-5
36	P IX.5 L	5-10.1
37	P X R	0-6
38	P X R	6-11.6
39	P X.5 C	0-5
40	P X.5 C	5-11
41	P XI L	0-3.5
42	P XII R	0-8.5
43	P XII RR	0-9.2
44	P XII B2	0-2
45	P XII B2	2-7.5
45	P XII B2	2-7.5
46	P XII B2	7.5-12.5
47	P XII B1	0-5
48	P XII B1	5-11.1
49	P XII.5 C	0-6
49	P XII.5 C	0-6
50	P XII.5 R	0-5.3
51	P XII.5 R	5.3-11.1
52	P XIII L	0-6
52	P XIII L	0-6
53	P XIII R	0-5
54	P XIII R	5-10
59	P XIV C	0-4.5
	Carquinez Strait	
60	CB 1	0-6.6
61	C I R	0-6
61	C I R	0-6
63	CB 4 A	0-3.8
64	CB 4 A	3.8-11.4
65	CB 5	0-4
66	CB 6	0-6.5
67	CB 7	0-3.1
68	C II C	0-4
69	C II C	4-6.9
70	C II R	0-2.4

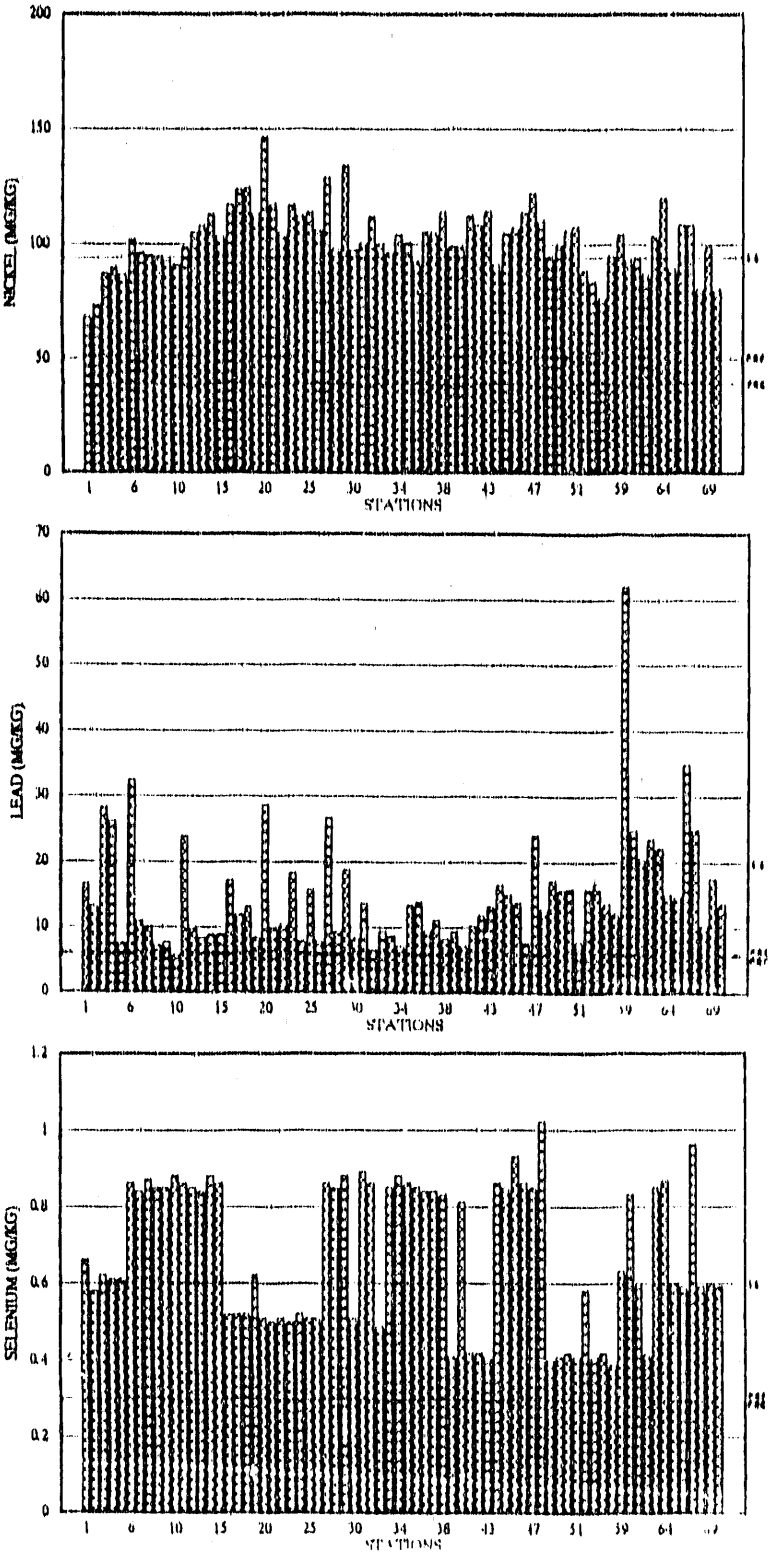


FIGURE 3.18. Concentrations of Nickel, Lead, and Selenium in John F. Baldwin Samples (SS=Shale Soil Concentration; PRC=Point Reyes Coarse Sediment Concentration; PRF=Point Reyes Fine Sediment Concentration)

cases the analytical detection limit for Se (0.41 to 0.89 mg/kg) exceeded the measured concentrations for Point Reyes sediments (0.31 to 0.34 mg/kg). In 32 samples, the detection limit exceeded the average shale soil Se concentration of 0.60 mg/kg; however, all John F. Baldwin Ship Channel detected levels were similar to those found in Richmond and Oakland harbors (Brown et al. 1989; Word et al. 1988, 1990a,b). Because these detection limits only tell the maximum possible concentration, and not the actual concentration, it is not possible to truly compare most John F. Baldwin Ship Channel sediment Se levels with Point Reyes or shale reference sediments. Figure 3.18 compares the Se detection limit with the reference sediments even if Se was not detected.

Thallium concentrations in sediment from the John F. Baldwin Ship Channel ranged from 0.31 to 0.77 mg/kg dry wt (Table 3.4). Thallium was below detection (0.42 mg/kg) in nine samples. All but eight of the samples had concentrations of Tl that exceeded the range of 0.34 to 0.44 mg/kg measured in the Point Reyes reference sites (Figure 3.19), but none exceeded the average shale sediment concentration of 1.0 mg/kg (Krauskopf 1967).

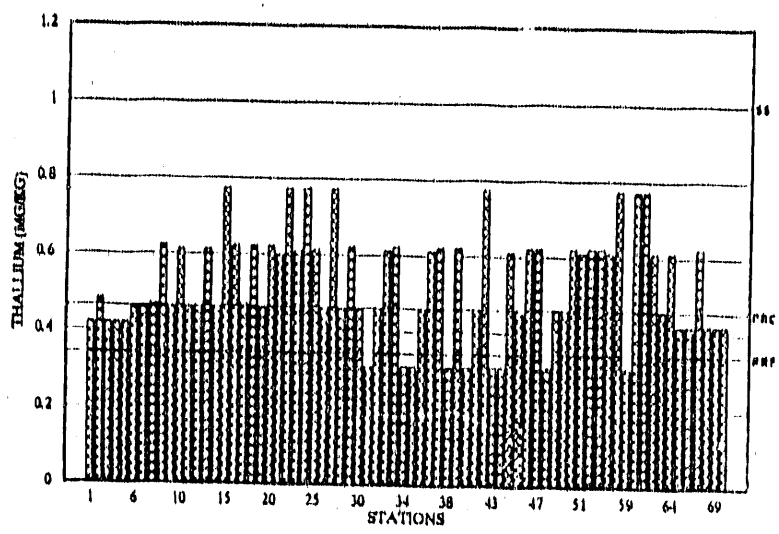
Zinc concentrations in sediment from the John F. Baldwin Ship Channel ranged from 68.3 to 162.3 mg/kg dry wt (Table 3.4). All stations had concentrations of Zn that exceeded the range of 36 to 55 mg/kg measured at Point Reyes reference sites (Figure 3.19), and all but 17 exceeded the average shale content of 80 mg/kg (Krauskopf 1967). Zinc concentrations in John F. Baldwin Ship Channel samples were 30% or more above average shale concentrations and were distributed through all reaches of the channel. Maximum Zn concentrations in John F. Baldwin Ship Channel sediments equaled maximum levels in Richmond Harbor (Brown et al. 1989), but were much lower than Zn concentrations measured in Oakland Harbor (Word et al. 1988, 1990a,b).

3.3.4 Butyltins

3.3.4.1 Quality Control Summary

Butyltin quality control results are summarized in Appendix D, Table D.6. The target detection limit of 0.01 mg/kg (10 μg/kg) was met for all butyltins, including tetra-, tri-, di-, and monobutyltin species, with actual detection limits generally at or below 1.0 μg/kg. The propyl tin surrogate recovery in

Code	Station	Section
West Richmond		
1	WR VII C	0-6.6
2	WR VI L	0-4
3	WR V L	0-6
4	WR IV.6 C	0-4
5	WR IV.6 C	4-8
6	WR IV R	0-6
7	WR IV R	3-11.6
7	WR IV R	6-11.6
8	WR III L	0-6.6
9	WR III C	0-6.4
10	WR II L	0-6.9
11	WR I R	0-6.1
Pinole Shoal		
12	P I C	0-3
13	P II C	0-4.3
14	P III L	0-3
15	P IV R	0-8
16	P V L	0-6.4
17	P V C	0-6.7
18	P V R	0-6
19	P V R	6-10.6
20	P VI L	0-6
21	P VI L	6-11.6
22	P VI C	0-9
23	P VI R	0-6
24	P VI R	6-11.7
25	P VII C	0-6
26	P VII C	6-10.1
27	P VIII L	0-6.6
28	P VIII L	6.6-9.6
29	P VIII R	0-6
30	P VIII R	6-10.6
31	P VIII.6 C	0-3.6
32	P VIII.6 C	3.6-10.4
32	P VIII.6 C	3.6-10.4
33	P IX C	0-6
34	P IX C	6-11.6
35	P IX.6 L	0-6
35	P IX.6 L	0-6
36	P IX.6 L	6-10.1
37	P X R	0-6
38	P X R	6-11.6
39	P X.6 C	0-6
40	P X.6 C	6-11
41	P XI L	0-3.6
42	P XII R	0-6.6
43	P XII RR	0-9.2
44	P XII B2	0-2
45	P XII B2	2-7.6
46	P XII B2	2-7.6
46	P XII B2	7.6-12.6
47	P XII B1	0-6
48	P XII B1	6-11.1
49	P XII.3 C	0-6
49	P XII.6 C	0-6
50	P XII.6 R	0-6.3
51	P XII.6 R	6.3-11.1
52	P XIII L	0-6
52	P XIII L	0-6
53	P XIII R	0-6
54	P XIII R	6-10
59	P XIV C	0-4.6
Carquinez Strait		
60	CB 1	0-6.6
61	C I R	0-6
61	C I R	0-6
63	CB 4 A	0-3.8
64	CB 4 A	3.8-11.4
65	CB 5	0-4
66	CB 6	0-6.5
67	CB 7	0-3.1
68	C II C	0-4
69	C II C	4-6.8
70	C II R	0-2.4



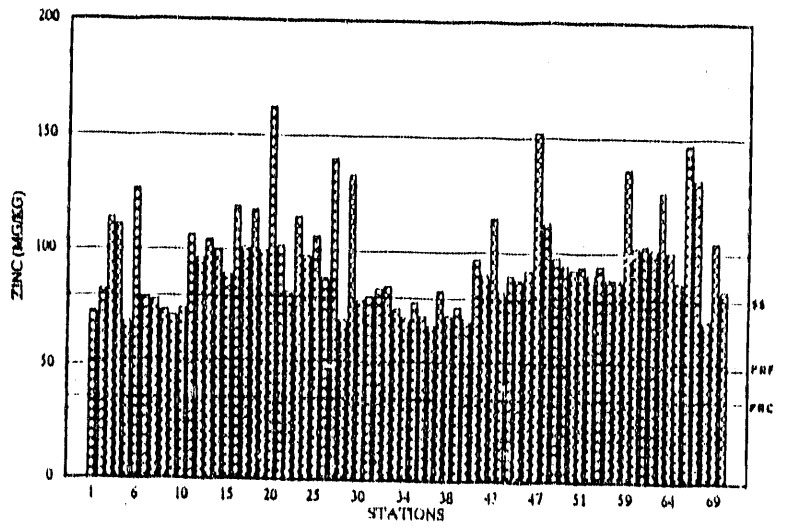


FIGURE 3.19. Concentrations of Thallium and Zinc in John F. Baldwin Samples (SS= Shale Soil Concentration; PRC=Point Reyes Coarse Sediment Concentration; PRF=Point Reyes Fine Sediment Concentration)

the sediment samples ranged from 31 to 125%, with most recoveries in the 50 to 70% range. Method blank data showed little or no butyltin contamination in four of the five blanks analyzed, with propyl tin surrogate recoveries ranging from 53 to 113%. Blank surrogate recoveries were within the target range of 40 to 120%. Blank contamination in the fifth blank was less than one third the target detection limit, and should be acceptable for quantifying butyltins at less than 10 μg/kg dry wt. Matrix spike recoveries were 52 to 99% for tributyltin, 43 to 89% for dibutyltin, and 23 to 82% for monobutyltin. Monobutyltin spikes generally have lower recovery than other butyltin species; only two monobutyltin recoveries fell below the target recovery range of 40 to 120%.

Analysis of the NRCC SRM PACS-1 yielded a result of 617 μg/kg tributyltin (TBT) with a 52% propyl tin recovery. The NRCC PACS-1 certified value of 1.27 ± 0.22 mg/kg TBT was obtained after correcting for surrogate recovery. Correcting our measured value for surrogate recovery resulted in 1.19 mg/kg TBT. This is well within the range of acceptable values for PACS-1 and confirms the accuracy of the measurements made for the John F. Baldwin program. Analysis of NOAA reference sediment SQ-1 yielded a similar result (58 μg/kg TBT) to the average TBT in 20 recent analyses by MSL (57.2 μg/kg; sd = 20). Analysis of compositing duplicates of seven sediment samples resulted in RPDs ranging from 49 to 101% for tributyltin, 36 to 199% for dibutyltin, and 39 to 43% for monobutyltin. Most of these RPDs are outside our target value of ≤25%. This is probably because the butyltins in these samples were near or below the detection limit. The results of these quality control analyses indicate that the butyltin data are acceptable, although care should be taken when interpreting the monobutyltin data because of low recoveries in some of the matrix spike samples.

3.3.4.2 Butyltin Results

Results of butyltin analyses of John F. Baldwin Ship Channel sediment samples are presented in Table 3.5 and in Appendix C, Table C.7. Individual species (mono-, di-, and tributyltin) concentrations and a calculated total concentration are reported. These concentrations are shown graphically in Figure 3.20. Dry weight concentrations for monobutyltin ranged from undetected to 4.1 μg/kg, for dibutyltin from undetected to 15 μg/kg, and for

TABLE 3.5. Butyltins in John F. Baldwin Ship Channel Sediments (< = not detected above given detection limit; N/A = not applicable)

Station, Section, ft		Propyl Tin Recovery, %	Butyltin Species, µg/kg Tri-	Di-	Mono-	Total
Detection Limits						
Target DL		N/A	10	10	10	N/A
Lowest achieved DL		N/A	0.40	0.41	0.42	N/A
Maximum achieved DL		N/A	0.80	0.83	2.3	N/A
West Richmond						
WR VII C	0-5.5	36	1.8	15	1.2	18
WR VI L	0-4	56	0.82	7.1	1.6	9.5
WR V L	0-6	43	7.3	12	<2.3	19.3
WR IV.5 C	0-4	48	<0.74	2.1	<0.76	2.1
WR IV.5 C	4-8	36	<0.62	0.74	<0.63	0.74
WR IV R	0-6	82	2.3	5.1	<2.0	7.4
WR IV R	6-11.5 rep 1	45	0.81	<0.55	<0.56	0.81
WR IV R	6-11.5 rep 2	63	0.49	0.97	<0.46	1.46
WR III L	0-6.6	45	0.53	<0.55	<0.56	0.53
WR III C	0-6.4	45	<0.56	0.71	<0.57	0.71
WR II L	0-6.9	51	<0.49	<0.50	<0.50	N/A
WR I R	0-5.1	45	2.1	7.9	3.0	13.0
Pinole Shoal						
P I C	0-3	54	0.83	<0.72	<0.73	0.83
P II C	0-4.3	31	1	3.5	1.1	5.6
P III L	0-3	38	0.74	0.68	<0.69	1.42
P IV R	0-8	68	0.96	1.3	1.0	3.3
P V L	0-8.4	39	0.93	1.7	0.83	3.5
P V C	0-8.7	57	<0.80	<0.83	<0.84	N/A
P V R	0-5	63	<0.63	0.66	<0.41	0.66
P V R	5-10.5	58	<0.66	<0.68	<0.70	N/A
P VI L	0-5	55	0.71	<0.67	<0.68	0.71
P VI L	5-11.6	42	0.63	3.2	<0.66	4.5
P VI C	0-9	49	0.81	1.7	0.81	3.3
P VI R	0-5	53	1.6	1.2	0.69	3.5
P VI R	5-11.7	97	2.7	4.5	1.5	8.7
P VII C	0-5	39	0.63	2.5	0.68	3.8
P VII C	5-10.1	83	2.6	6.5	0.97	10.1
P VIII L	0-6.6	68	4.0	0.71	2.4	7.1
P VIII L	6.6-9.5	53	<0.40	<0.41	<0.42	N/A
P VIII R	0-8	70	3.9	2.1	1.9	7.9
P VIII R	8-10.5	52	<0.54	1.5	0.57	1.5

TABLE 3.5. (contd)

Station, Section, ft		Propyl Tin Recovery, %	Butyltin Species, µg/kg Tri-	Di-	Mono-	Total
Pinole Shoal (contd)						
P VIII.5 C	0-3.6	46	2.1	0.74	<0.47	2.8
P VIII.5 C	3.6-10.4 rep 1	58	<0.49	0.57	<0.52	0.57
P VIII.5 C	3.6-10.4 rep 2	54	<0.59	1.1	<0.62	1.1
P IX C	0-5	47	<0.50	<0.51	<0.52	N/A
P IX C	5-11.8	48	<0.46	<0.47	<0.48	N/A
P IX.5 L	0-5 rep 1	53	<0.48	<0.48	<0.49	N/A
P IX.5 L	0-5 rep 2	71	0.55	0.56	0.47	1.58
P IX.5 L	5-10.1	63	0.58	0.72	<0.49	1.3
P X R	0-6	80	2.0	2.8	1.2	6.0
P X R	6-11.5	42	0.48	<0.47	<0.48	0.48
P X.5 C	0-5	43	0.53	0.57	<0.50	1.10
P X.5 C	5-11	43	0.48	<0.47	<0.48	0.48
P XI L	0-3.5	63	<0.59	<0.58	<0.60	N/A
P XII R	0-8.5	31	<0.62	<0.62	<0.64	N/A
P XII RR	0-9.2	125	3.7	1.7	1.3	6.7
P XII B2	0-2	46	1.5	1.3	<0.92	2.8
P XII B2	2-7.5 rep 1	45	0.89	1.0	2.0	3.9
P XII B2	2-7.5 rep 2	79	2.7	11	3.1	17.0
P XII B2	7.5-12.5	69	0.75	3.1	0.95	4.8
P XII B1	0-5	66	2.1	5	2.4	9.5
P XII B1	5-11.1	46	0.89	3.1	<0.58	4.0
P XII.5 C	0-6 rep 1	42	0.67	1.4	0.88	2.9
P XII.5 C	0-6 rep 2	60	0.87	<0.77	<0.59	0.87
P XII.5 R	0-5.3	22	2.5	0.88	0.78	4.2
P XII.5 R	5.3-11.1	92	3.0	<0.69	1.0	4.0
P XIII L	0-6 rep 1	36	3.1	6.5	1.5	11.1
P XIII L	0-6 rep 2	43	<0.57	1.3	0.74	2.0
P XIII R	0-5	72	2.1	1.9	<0.67	4.0
P XIII R	5-10	45	1.5	1.2	0.66	3.4
P XIV C	0-4.5	45	<0.59	0.59	0.71	1.30
Carquinez Strait						
CB 1	0-6.6	81	2.5	2.1	1.3	5.9
C I R	0-8 rep 1	41	1.7	2.6	0.74	5.0
C I R	0-8 rep 2	64	2.9	1.8	1.1	5.8
CB 4 A	0-3.8	37	6.1	12	3.3	21
CB 4 A	3.8-11.4	37	0.57	1.5	<0.55	2.1
CB 5	0-4	42	0.57	1.4	<0.56	2.0
CB 6	0-6.5	86	2.8	3.5	1.1	7.4
CB 7	0-3.1	33	29	3.5	4.1	37
C II C	0-4	39	<0.51	1.3	<0.52	1.3
C II C	4-6.8	40	<0.61	5.8	1.0	6.8
C II R	0-2.4	40	1.2	1.3	0.97	3.5

Code	Station	Section
West Richmond		
1	WR VII C	0-5.5
2	WR VI L	0-4
3	WR V L	0-6
4	WR IV.5 C	0-4
5	WR IV.5 C	4-8
6	WR IV R	0-6
7	WR IV R	6-11.5
7	WR IV R	6-11.5
8	WR III L	0-6.6
9	WR III C	0-6.4
10	WR II L	0-6.9
11	WR I R	0-5.1
Pinole Shoal		
12	P I C	0-3
13	P II C	0-4.3
14	P III L	0-3
15	P IV R	0-8
16	P V L	0-8.4
17	P V C	0-8.7
18	P V R	0-5
19	P V R	5-10.5
20	P VI L	0-5
21	P VI L	5-11.6
22	P VI C	0-9
23	P VI R	0-5
24	P VI R	5-11.7
25	P VII C	0-5
26	P VII C	5-10.1
27	P VIII L	0-6.6
28	P VIII L	6.6-9.5
29	P VIII R	0-8
30	P VIII R	8-10.5
31	P VIII.5 C	0-3.6
32	P VIII.5 C	3.6-10.4
32	P VIII.5 C	3.6-10.4
33	P IX C	0-5
34	P IX C	5-11.8
35	P IX.5 L	0-5
35	P IX.5 L	0-5
36	P IX.5 L	5-10.1
37	P X R	0-6
38	P X R	6-11.5
39	P X.5 C	0-5
40	P X.5 C	5-11
41	P XI L	0-8.5
42	P XII R	0-8.5
43	P XII RR	0-9.2
44	P XII B2	0-2
45	P XII B2	2-7.5
45	P XII B2	2-7.5
46	P XII B2	7.5-12.5
47	P XII B1	0-5
48	P XII B1	5-11.1
49	P XII.5 C	0-6
49	P XII.5 C	0-6
50	P XII.5 R	0-[illegible]
51	P XII.5 R	5.3-11.1
52	P XIII L	0-6
52	P XIII L	0-6
53	P XIII R	0-5
54	P XIII R	5-10
55	P XIII B3	0-6
56	P XIII B3	6-10
57	P XIII B4	0-4
58	P XIII B4	4-8
59	P XIV C	0-4.5
Carquinez Strait		
60	CB 1	0-6.6
61	C I R	0-8
61	C I R	0-8
62	CB 2	0-6.8
63	CB 4 A	0-3.8
64	CB 4 A	3.8-11.4
65	CB 5	0-4
66	CB 6	0-6.5
67	CB 7	0-3.1
68	C II C	0-4
69	C II C	4-6.8
70	C II R	0-2.4

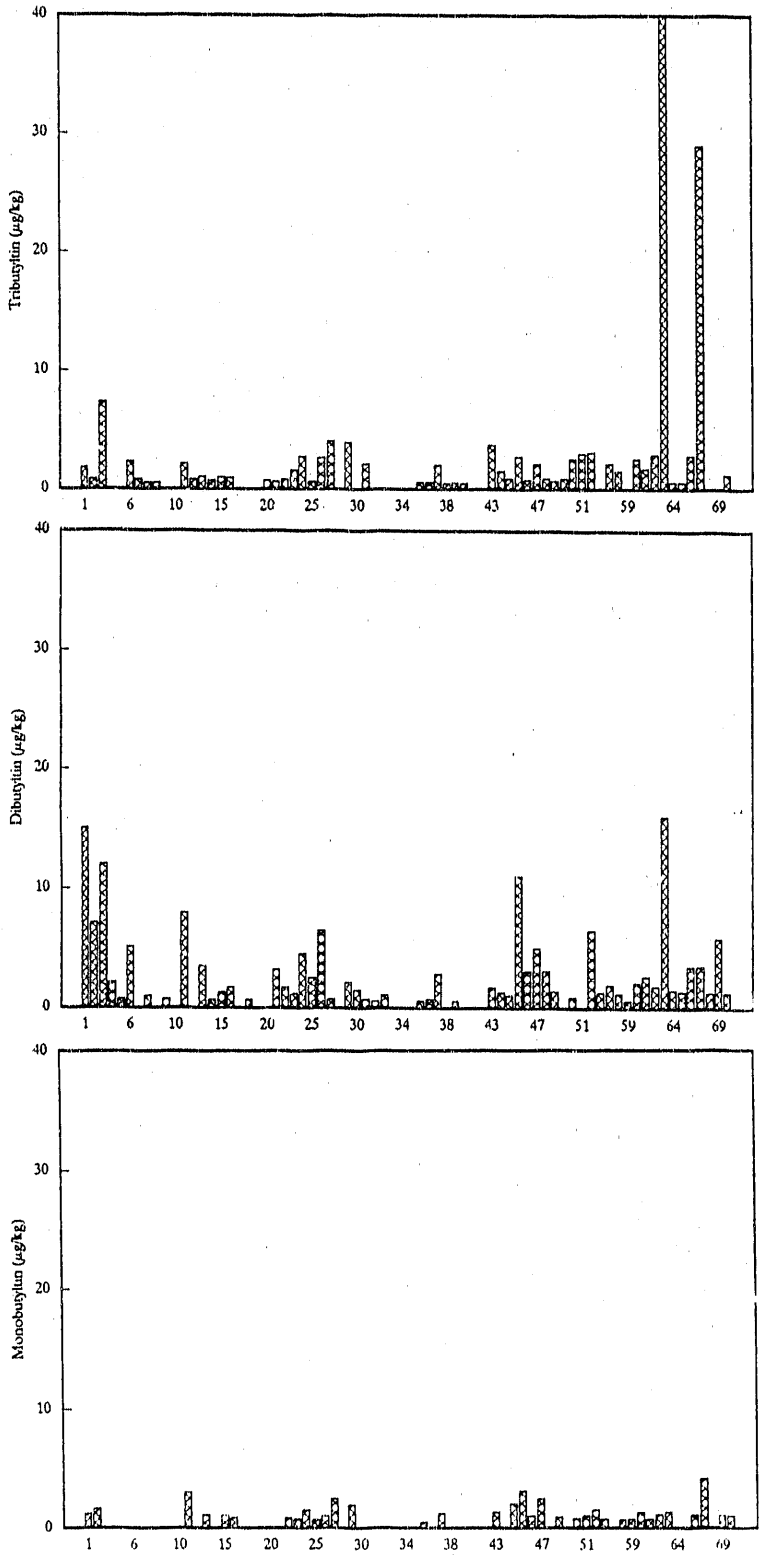


FIGURE 3.20. Concentrations of Tri-, Di-, and Monobutyltin Detected in John F. Baldwin Sediment

tributyltin from undetected to 29 μg/kg. Four of the West Richmond stations had total butyltin concentrations that were <1 μg/kg dry wt, four others that were >1, but <10 μg/kg dry wt, and three that were >10 μg/kg, with the greatest concentration being 19.3 μg/kg dry wt. In all cases, the concentrations of dibutyltin were greater than either tri- or monobutyltin, indicating tributyltin weathering or potentially an additional source of plastic contamination.

In the Pinole Shoal area, the concentrations of total butyltin ranged from undetected to 21.4 μg/kg, with 16 stations having <1 μg/kg, 31 others that were >1, but <10 μg/kg, and 3 others that were >10 μg/kg. Again, sediment at all but 10 stations had dibutyltin concentrations that were greater than tri- or monobutyltin concentrations, indicating tributyltin weathering or low-level plastic contamination. The 10 stations that had higher concentrations of tributyltin included P VI R, P VIII L, P VIII R, P VIII.5 C, P XII RR, P XII B2, P XII.5 R, P XII.5 R, P XIII R (0-5), and P XIII R (5-10).

All stations in the Carquinez Strait had measurable concentrations of total butyltin that ranged from 1.3 to 37 μg/kg. Nine of the 11 stations had total butyltin concentrations that were >1, but <10 μg/kg, while the remaining two had concentrations >10 μg/kg. Again, the majority of stations (9 of 12) had dibutyltin concentrations that exceeded the concentration of tri- or monobutyltin. The remaining three stations (CB 1, C I R, and CB 7) had higher concentrations of tributyltin than either mono- or dibutyltin. Where dibutyltin is higher, it probably indicates weathering of tributyltins or low-level plastic contamination. Where tributyltin is higher, an unweathered source of tributyltin is present.

3.3.5 Semivolatile Organic Compounds

3.3.5.1 Quality Control Summary

The semivolatile organic compounds measured in John F. Baldwin Ship Channel sediments were the 16 PAHs listed in EPA Method 610. Quality control data for PAH analysis are contained in Appendix D, Tables D.7 and D.8. The target detection limit of 20.0 μg/kg was met for all compounds. Recoveries of the base/neutral surrogate compounds were within the acceptable limits for all

three compounds in all samples (Appendix D, Table D.7), with only one exception; in Station P VI R 0-5, 2-fluorobiphenyl recovery was 29%, just below the 30-115% QC acceptance range. The sample was not reextracted as the other surrogate recoveries were acceptable.

Nine method blanks were analyzed; the results, summarized in Appendix D, Table D.8 show that all compounds were undetected in the blanks. Seven samples were duplicated to assess analytical precision; only one set of duplicates (Station WR IV R 0-6) had PAH levels above detection. Comparison of the measured values in the analytical duplicates yielded RPDs ranging from 0 to 81.6%. The compounds that did not compare well (RPD <25%) were anthracene, benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene. Samples from Station WR IV R 6-11.5 were the only set of compositing duplicates where the compounds were above the detection limit. Comparison of compositing duplicates produced RPDs ranging from 19 to 105%, showing heterogeneity of sediment composites.

To assess accuracy, matrix spike evaluations were performed on seven samples. With very few exceptions, these data show that spike recoveries were acceptable for all compounds in all samples. The exceptions were acenaphthene recovery in Stations P IX.5 L (34%) and P XII.5 C (39%) and fluorene recovery in Stations P IX.5 L (41%) and P XIII L (58%). Two SRMs, NRCC HS-3 and SES-1, were also analyzed. The results of HS-3 analysis showed accurate measurement of 11 of 16 compounds. No result was reported for benzo(k)fluoranthene. The measured values fell outside of the certified SRM range, but were generally close to the range, for anthracene, chrysene, fluoranthene, and indeno(1,2,3-c,d)pyrene (Appendix D, Table D.8). The analytical results for SRM SES-1 were less impressive, with differences between measured and certified concentrations ranging from 1.3 to 71%. However, according to the certification sheet from NRCC, the certified values in SRM SES-1 are the result of between only 6 and 12 analyses; the ranges and standard deviations of these results are not provided. Therefore, it is not possible to assess the accuracy of our measurements compared to SRM SES-1. Unless ranges and standard deviations can be provided, we do not intend to use SRM SES-1 as a standard in future programs.

3.3.5.2 Results of Semivolatile Organics Analysis

Semivolatile (PAH) organic compounds were detected in sediment from 19 stations in the John F. Baldwin Ship Channel (Table 3.6). Complete PAH data for all stations are presented in Appendix C, Table C.8. Concentrations of total detected PAH ranged from 11 to 3538 μg/kg dry wt, with most of the total PAH concentration (74 to 100%) attributable to high molecular weight polynuclear aromatic hydrocarbons (HPAH) (Table 3.7). Total PAH and HPAH are shown graphically in Figure 3.21, which also shows stations where PAHs were detected in relation to the entire channel.

Maximum concentrations of PAH occurred in the West Richmond sampling area. The highest concentration was observed at Station WR VII C and generally showed a decreasing level to the north of this location. All semivolatile compounds measured were found at this location, with progressively volatile fractions being absent from the stations north of Station WR VII C. This pattern is consistent with weathering of a source of PAH that is being transported away from the initial location nearer Station WR VII C. The presence of the more volatile compounds at Station WR VII C indicates that the source may be continuous, or that weathering of the material is very slow at Station WR VII C, but becomes more active during transport from this area.

The remaining locations in Pinole Shoal and in Carquinez Strait had relatively minor concentrations of HPAH compounds. The range in concentrations of total semivolatile organic compounds at these sites was 11 to 392 μg/kg dry wt. All but two stations (CB 7 and CB 4A) had values that were lower than the concentration range of total semivolatile organic compounds (67 to 253 μg/kg) observed at the Point Reyes, California, reference sites (Word et al. 1990b).

3.3.6 Chlorinated Pesticides and PCBs

3.3.6.1 Quality Control Summary

Quality control data for both chlorinated pesticide and PCB analyses on sediments from John F. Baldwin Ship Channel are presented in Table D.9, Appendix D. Target detection limits were achieved for all samples. No compounds were detected above the method detection limits in the method blank analyses. All results reported above MDLs were confirmed on a second column. No

TABLE 3.6. Samples Where PAHs (μg/kg, compounds in order of increasing molecular weight) Were Detected in John F. Baldwin Ship Channel Sediments (** = not detected in sample; see individual detection limits in Appendix C, Table C.8)

		LPAH						HPAH									
Station, Section, ft		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Detection Limits																	
Target DL		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Lowest achieved DL		2.9	3.1	3.1	3.1	3.6	3.4	5.6	6.8	2.2	2.7	3.1	4.1	2.7	4.5	3.4	5.6
Maximum achieved DL		6.5	6.9	6.9	6.9	6.9	7.7	12.0	15.0	4.9	5.8	6.5	9.3	5.8	10.0	7.7	13.0
WR VII C	0-5.5	21.0	25.0	17.0	28.0	360.0	110.0	370.0	760.0	300.0	320.0	210.0	230.0	370.0	170.0	27.0	220.0
WR VI L	0-4	**	15.0	26.0	16.0	340.0	87.0	430.0	590.0	150.0	160.0	160.0	190.0	310.0	96.0	**	170.0
WR V L	0-6	17.0	21.0	38.0	23.0	510.0	100.0	420.0	770.0	180.0	190.0	160.0	170.0	270.0	86.0	**	120.0
WR IV.5 C	0-4	**	21.0	**	17.0	270.0	58.0	240.0	380.0	97.0	120.0	120.0	120.0	170.0	60.0	**	110.0
WR IV R	0-6	20.0	**	**	**	160.0	69.0	170.0	410.0	110.0	130.0	150.0	140.0	220.0	100.0	**	150.0
WR IV R	6-11.5(a)	**	**	**	**	76.0	31.5	76.0	100.5	44.5	37.5	18.5	32.0	40.0	**	**	17.0
WR I R	0-5.1	**	**	**	**	79.0	23.0	90.0	130.0	56.0	61.0	65.0	72.0	130.0	62.0	**	110.0
P V R	0-5	**	**	**	**	**	**	**	17.0	**	**	**	**	**	**	**	**
P VI L	0-5	**	**	**	**	18.0	**	23.0	61.0	**	27.0	18.0	**	19.0	**	**	**
P VII C	0-5	**	**	**	**	**	**	11.0	**	**	**	**	**	**	**	**	**
P VIII L	0-6.6	**	**	**	**	**	**	15.0	27.0	**	13.0	**	**	**	**	**	**
P VIII R	0-8	**	**	**	**	**	**	**	18.0	**	**	**	**	**	**	**	**
P XII B1	0-5	**	**	**	**	17.0	**	24.0	25.0	**	**	**	**	**	**	**	**
P XIII L	0-6	**	**	**	**	**	**	11.0	15.0	**	**	**	**	**	**	**	**
P XIV C	0-4.5	**	**	**	**	**	**	23.0	57.0	14.0	21.0	21.0	**	26.0	**	**	17.0
CB 4 A	0-3.8	**	**	**	**	34.0	**	72.0	110.0	32.0	42.0	39.0	30.0	33.0	**	**	**
CB 6	0-6.5	**	**	**	**	15.0	**	16.0	53.0	11.0	19.0	15.0	10.0	15.0	**	**	13.0
CB 7	0-3.1	**	**	**	**	21.0	**	22.0	65.0	19.0	26.0	24.0	16.0	24.0	16.0	**	27.0
C II C	4-6.8	**	**	**	**	**	**	**	26.0	**	**	**	**	**	**	**	**

(a) Reported concentration is the average concentration of compositing duplicates, or the detected value if found in only one of the duplicates.

1. Naphthalene	LPAH	5. Phenanthrene	LPAH	9. Benzo(a)anthracene	HPAH	13. Benzo(a)pyrene	HPAH
2. Acenaphthylene	LPAH	6. Anthracene	LPAH	10. Chrysene	HPAH	14. Indeno(1,2,3-c,d)pyrene	HPAH
3. Acenaphthene	LPAH	7. Fluoranthene	HPAH	11. Benzo(b)fluoranthene	HPAH	15. Dibenz(a,h)anthracene	HPAH
4. Fluorene	LPAH	8. Pyrene	HPAH	12. Benzo(k)fluoranthene	HPAH	16. Benzo(g,h,i)perylene	HPAH

TABLE 3.7. For Stations Where PAHs Were Detected, Total PAH and High Molecular Weight (HPAH) Fraction in John F. Baldwin Ship Channel Sediments (N/A = not applicable)

Station, Section, ft		Total PAH µg/kg	HPAH µg/kg	% HPAH	Comment
WR VII C	0-5.5	3538	2977	84	
WR V L	0-6	3075	2366	77	
WR VI L	0-4	2740	2256	82	
WR IV R	0-6	1829	1580	86	
WR IV R	6-11.5[a]	474	366	77	
WR IV.5 C	0-4	1783	1417	79	PAH in upper 4 ft of core only
WR IV.5 C	4-8	0	0	N/A	
WR I R	0-5.1	878	776	88	
CB 4 A	0-3.8	392	358	91	PAH in upper 3.8 ft of core only
CB 4 A	3.8-11.4	0	0	N/A	
CB 7	0-3.1	260	239	92	
P XIV C	0-4.5	179	179	100	
CB 6	0-6.5	167	152	91	
P VI L	0-5	166	148	89	PAH in upper 5 ft of core only
P VI L	5-11.6	0	0	N/A	
P XII B1	0-5	66	49	74	PAH in upper 5 ft of core only
P XII B1	5-11.1	0	0	N/A	
P VIII L	0-6.6	55	55	100	PAH in upper 6.6 ft of core only
P VIII L	6.6-9.5	0	0	N/A	
P XIII L	0-6(a)	26	26	100	
C II C	0-4	0	0	N/A	
C II C	4-6.8	26	26	100	PAH in lower part of core
P VIII R	0-8	18	18	100	
P VIII R	8-10.5	0	0	N/A	
P V R	0-5	17	17	100	PAH in upper 5 ft of core only
P V R	5-10.5	0	0	N/A	
P VII C	0-5	11	11	100	PAH in upper 5 ft of core only
P VII C	5-10.1	0	0	N/A	

(a) Reported concentration is the average concentration of compositing duplicates, or the detected value if found in only one of the duplicates.

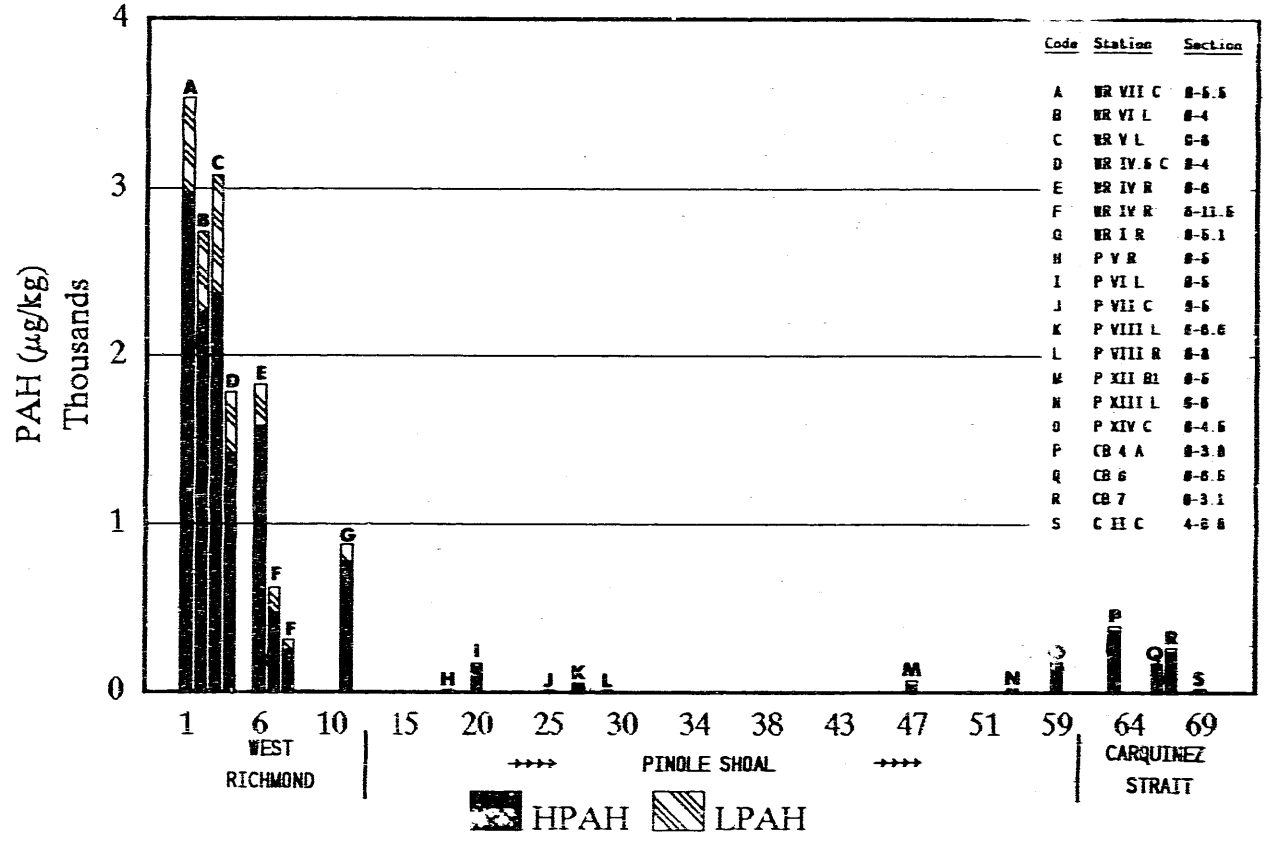


FIGURE 3.21. High and Low Molecular Weight of Polynuclear Aromatic Hydrocarbons in John F. Baldwin Ship Channel Sediment

compounds were detected in duplicate samples analyzed to assess both compositing and analytical precision. This precluded calculations of RPDs for these analyses. The exceptions were low-level detections of a single pesticide in only one of the composites and one of the analytical replicate pairs. This occurrence could be attributed to sample heterogeneity and matrix variability. Analytical accuracy was assessed through analysis of seven matrix spike samples. Samples were spiked with a mixture of six pesticides and one PCB Aroclor (Aroclor 1242). In all cases, spike recoveries were within the control limits, and in most cases the recoveries were over 75%.

3.3.6.2 Chlorinated Pesticide and PCB Results

Chlorinated pesticide and PCB data are presented in Appendix C, Table C.9. Table 3.8 summarizes the sample locations of detected compounds. Only two pesticides, β-BHC and δ-BHC, were detected in six sediment samples. These samples were from four locations in Pinole Shoal and two locations in Carquinez Strait. No PCBs were detected in any sediment samples collected.

TABLE 3.8. Stations Where Chlorinated Pesticides and PCBs (μg/kg dry weight) Were Detected in John F. Baldwin Ship Channel Sediments (** = not detected above given detection limit).

Station, Section, ft		β-BHC	δ-BHC
DL		4.0	8.0
West Richmond			
No Pesticides or PCBs Detected			
Pinole Shoal			
P XII R	0-8.5	10	26
P XII B2	2-7.5	**	31
P XII B1	0-5	**	29
P XII.5 R	5.3-11.1	**	13
Carquinez Strait			
CB 1	0-6.6	**	17
CB 4 A	3.8-11.4	**	19

4.0 CONCLUSIONS

The sediments of the John F. Baldwin Ship Channel exhibit an uneven distribution of the physical and chemical characteristics measured during this study. This is not surprising, for the study area represents a 28-mile stretch of channel through a dynamic estuarine environment. Our conclusions relate to the identification of trends in sediment characteristics, as well as the presence of unusual relationships. Locations are noted where contaminant levels appear elevated compared with reference sediment from Point Reyes, typical shale sediments, or where a variety of contaminants were detected. The following sections describe characteristics observed in sediments from West Richmond; southwestern, central, and northeastern regions of Pinole Shoal; and Carquinez Strait.

4.1 WEST RICHMOND

In the West Richmond reach of the John F. Baldwin Ship Channel, TOC is well correlated with the grain size, and selected metals levels appear elevated compared with Point Reyes reference sediment or typical shale soils. The metals concentrations generally appear to be related to the TOC concentrations throughout West Richmond, indicating a common source of metals and organic carbon related to grain size. However, certain metals appear to have concentrations elevated above expected values based on these relationships at some of the West Richmond stations. These metals are As from the lower 4 to 8 ft of cores from Station WR IV.5 C and Ag, Pb, and Zn within the upper 4 to 6 ft of cores from Stations WR V L, WR IV.5 C, and WR IV R.

The significance of these metals concentrations can be approximated by using a model based on partitioning coefficients that predicts the relationship between estuarine sediment and water. These relationships have been used to predict the release of metals from sediments at concentrations that exceed acute or chronic marine water quality criteria developed by EPA (Felstul personal communication 1987). The 4-day average EPA Goldbook Criteria for saltwater acute toxicity values are 36, 5.6, and 86 μg/L for As, Pb, and Zn, respectively. Silver's criteria value is 50 μg/L. Using Felstul's model to predict potential contaminant release from the sediment to the water indicates

that the maximum Ag, Pb, and Zn releases would be less than 1%, while the maximum As value is less than 40% of the acute Gold Book Criteria values. It does not appear that these metals in West Richmond sediments would contribute any observed acute toxicity responses to organisms that may be tested in the future.

What separates West Richmond from the other sampling areas is the concentrations and types of PAH found in the sediments. Sediment from the southernmost station, WRVII, contains both low molecular weight (LPAH) and high molecular weight (HPAH) compounds. This pattern is retained for adjacent stations in the southern part of the channel except that the lower molecular weight PAH compounds are sequentially lost from stations farther north of Station WRVII. The highest concentrations of low molecular weight PAH and total PAH occur in the southern part of the channel (Stations WR VII, WR VI, and WR V). Examination of the PAH chromatograms of West Richmond samples also show that more volatile compounds (lighter than LPAH) are present, indicating a possible source of petroleum hydrocarbons near Station WR VII. The source provides relatively unweathered PAH near Station WR VII with possible transport to the north resulting in more diluted concentrations of total PAH and a weathering loss of LPAH. The exact location of the source is not known, but should be close to Station WR VII. Additional evaluation of potential biological impacts of these sediments is recommended.

Total butyltin concentrations in sediment in the West Richmond area ranged from undetected to as high as 20 μg/kg (dry wt) with the more toxic tributyltin form ranging from 8.6 to 37.8% of the total butyltins. This more toxic form ranged from not detected at less than 1 to a detected value of 7 μg/kg (dry wt). Using the equation of Valkirs et al. (1986), the concentration of tributyltins in the interstitial water is estimated to be approximately 0.004 μg/L, which is less than 1% of the acute and approximately 6% of the chronic marine water quality criteria of 0.22 and 0.069 μg/L, respectively. It does not appear that organotins in the West Richmond area should be a concern for potential acute or chronic toxicity.

4.2 SOUTHWESTERN PINOLE SHOAL (Stations P I to P V)

This geographical section of the study is segregated from the others because of a lack of any outstanding or unusual data. Cores from this area had finer-grained sediment that correlated well with TOC levels. Metal concentrations also correlated well with TOC in southwestern Pinole Shoal. Although certain metals appear elevated in this region, the concentrations of metals are less than the reference sediments from Point Reyes, the typical shale soil concentrations, or the concentrations of those metals in the West Richmond area. It is unlikely that metals from sediments within this area would contribute to any observed acute toxicity during subsequent testing.

Polynuclear aromatic hydrocarbon concentrations in this area of the Pinole Shoal Channel were nondetected to very low. The only PAH found in the southwestern Pinole Shoal area was pyrene at 17 μg/kg (Station P V R). These values are actually less than concentrations observed in reference sediments off Point Reyes and much lower than other locations in this study. It is unlikely that PAH would contribute to acute toxicity during any subsequent testing.

Butyltin levels were low throughout this part of the channel, with a maximum total butyltin concentration of <6.0 μg/kg (dry wt). Maximum concentration of tributyltin was 1.0 μg/kg (dry wt), which is substantially lower than the levels of probable no effect observed in West Richmond sediments. It is unlikely that sediment from the southwestern area of the Pinole Shoal Channel would have any acute toxicity related to the butyltin concentrations observed.

4.3 CENTRAL PINOLE SHOAL (Stations P VI to P X.5)

In Stations P VI upchannel to P X.5 sediments are predominantly sand with corresponding low levels of TOC. Metals concentrations are also lower and generally correlate well with the coarser grain size and lower TOC. Two stations appear to have consistently higher concentrations of metals than the surrounding area. These stations are the upper 5 to 8 ft of Stations P VI L and P VIII R. The consistency of these elevated concentrations of metals at these two stations is most likely related to the higher levels of organic

carbon that also were present. However, sediment from these areas should be tested further for potential toxicity as a result of the consistently elevated levels of metals.

Polynuclear aromatic hydrocarbons were detected in only two samples from this portion of John F. Baldwin Ship Channel, Stations P VI L and P VIII L. Most PAH compounds were the HPAHs fluoranthene, pyrene, and chrysene. At Station P VI L, phenanthrene, benzo(b) fluoranthene, and benzo(a)pyrene were also present. In all cases, the total concentration of these higher molecular weight PAH compounds was at least 30 times lower than the concentrations observed in the West Richmond channel area. It is unlikely that PAH from these stations would contribute to any observed acute toxicity from subsequent acute toxicity tests.

Some butyltins were found in central Pinole Shoal, with the highest concentrations of tributyltin occurring at Station P VIII L (4 μg/kg) and Station VIII R (3.9 μg/kg). The highest total of butyltin species was found at Station P VII C (10.1 μg/kg) followed by P VI R (8.7 μg/kg), P VIII R (7.9 μg/kg), and P VIII L (7.1 μg/kg). These relatively low concentrations of tributyltin are approximately one-half of the highest levels observed in the West Richmond sediment. Those levels in West Richmond sediment were characterized through an organic carbon normalization formula (Valkirs et al. 1986) and were found to be from $\leq$1 to <6% of the acute and chronic marine water quality criteria. It is not anticipated that toxicity from sediment within the central Pinole Shoal area would be related to butyltin concentrations.

4.4 NORTHEASTERN PINOLE SHOAL (Stations P XI to P XIV)

Several features of the John F. Baldwin Ship Channel sediment characterization set the northeastern Pinole Shoal area apart from other sections of the channel. Organic carbon levels were not always well correlated with grain size, and generally higher concentrations of metals, notably Ag, As, Al, Cr, Cu, Hg, Pb, and Zn, were present at some stations. The majority of these elevated metal levels either occurred throughout the northeastern Pinole Shoal area (As, Hg, and Al), were located at one of two berthing areas (Stations PXII B 1 or PXII B 2), or in the case of Ag and Pb, were located at Station P XIV C.

The generally elevated levels of As, Hg, and Al were located near the opening of the Carquinez Strait. This seems reasonable because the Carquinez Strait area also appears to have relatively high levels of these same metals. The As and Hg levels are potentially of more concern than the slightly elevated levels of Al. The availability of these two metals are, however, unknown, and it is possible that they are a part of the mineral matrix rather than the bioavailable fraction of the sediment. Subsequent toxicity testing on sediments from these areas would better refine any potential toxicity. The elevated levels of multiple metals at the berthing areas and the levels of Ag and Pb at Station P XIV C also indicate a need for additional biological testing.

The berthing area at Station P XII B1 and Station P XIV C had slightly elevated levels of the higher molecular weight PAHs. The levels of PAH present in these sediment samples were much lower than observed in the West Richmond area and slightly lower than the values observed within Carquinez Strait. It is less likely that these materials would produce toxicity during subsequent testing.

One interesting observation made during the sampling was the presence of peat material in the lowest portion of the core from Station P XII.5 R. Chemical analyses of sediment from this portion of the core did not indicate elevated levels of any of the measured parameters. The type of material present could influence survival in sediment toxicity tests, but the toxicity would be related more to other parameters (e.g., oxygen demand) than to the chemicals measured.

4.5 CARQUINEZ STRAIT

The poorest overall correlation of TOC with grain size occurred in the Carquinez Strait area. All but two of the Carquinez Strait stations [CB 4 A (U) and C II C (U)] were outliers on the distribution of grain size relative to total organic carbon (Figure 3.13). Stations C II C (lower), CB 6, and CB 7 at the eastern end of Carquinez Strait had much higher TOC relative to percent sand than the correlation would predict. The other five stations had approximately the same TOC, but a wide range in percent sand.

Consistent lack of correlation was apparent between TOC and Al, As, and Hg. Each of these metals was higher in concentration at the easternmost Carquinez Strait stations, with the highest concentrations for any of the John F. Baldwin Ship Channel stations occurring at Station C II R. These high concentrations of potentially toxic metals occurring in sediments at levels not predicted based on grain size, TOC, or the proximity to a berthing area indicate that biological testing should be performed in the Carquinez Strait area.

The PAH levels from sediments at two berthing areas, Stations CB 7 and CB 4A, were higher than those of any other sampled areas in Pinole Shoal and second highest to the elevated West Richmond levels. More than 90% of the PAHs were the higher molecular weight PAHs with nearly all these compounds represented. This observation coupled with the presence of butyltins at elevated levels in these same samples suggests that biological testing should be performed on sediment from these locations in the subsequent testing phase of the program.

The highest concentrations of butyltins occurred in the Carquinez Strait sediments at two berthing areas, Stations CB 4A and CB 7. The concentration of the tributyltin form of these chemicals occurred at station CB 7 and was approximately 30 μg/kg (dry wt). The Valkirs et al. (1986) formulation predicts a concentration of tributyltin in water from this sediment value that would represent 8% of the acute and 25% of the chronic marine water quality criteria values. A possibility exists that the levels of tributyltin in these sediments at one berthing area, Station CB 7, might be high enough to contribute to toxicity.

In summary, the sediments from the John F. Baldwin Ship Channel show relatively lower contamination than sediments from either Richmond or Oakland harbors. The following summarizes conclusions from the chemical analyses performed during this first phase of testing:

- Potential toxicity to sensitive marine organisms exists from sediment in West Richmond as a result of the levels and types of PAHs present in the sediment.

- No reason exists to believe that potential toxicity would occur to sensitive marine organisms from sediment in the southwestern region of Pinole Shoal.
- Reason exists to believe a potential for toxicity to sensitive marine organisms may occur at stations within Central Pinole Shoal because of the presence of metals.
- Reason exists to believe a potential for toxicity to sensitive marine organisms may occur at stations within northeastern Pinole Shoal because of the presence of metals.
- Reason exists to believe potential for toxicity to sensitive marine organisms may occur at stations in Carquinez Strait because of the presence of metals, PAHs, and butyltins.

Because sediment values are above Point Reyes values, a potential for toxicity to sensitive marine organisms exists at the disposal site from sediments dredged from West Richmond (PAHs), central Pinole Shoal (metals), northeastern Pinole Shoal (metals), and Carquinez Strait (metals, PAHs, butyltins). Additional evaluations should be undertaken for sediments at these locations.

5.0 QUALITY ASSURANCE

At various stages of the John F. Baldwin Ship Channel program, surveillances and reviews were conducted by Battelle Quality Assurance Engineer Mr. Rob Cuello to ensure that the conditions of the Quality Assurance (QA) Plan were being met. Mr. Cuello traveled to the field to observe and review sampling operations. He also conducted a surveillance of laboratory compositing, sample preparation, storage, and shipping procedures. When chemistry data were submitted to MSL, program staff checked data entry to computer files against the raw data sheets; they also checked transcriptions between spreadsheet and text files for data reporting. Other QA activities by program personnel included hand-calculated verification of formulas in spreadsheets, tracking of chemistry QC procedures, and technical review of report drafts. Random data points in tables in report format were traced back to the raw data by Mr. Cuello to verify data traceability and to review record-keeping. Mr. Cuello will continue to perform traceability verification as outstanding data for organic compounds are submitted to MSL. These verification activities are retained in the project files to verify that QA procedures were followed.

6.0 REFERENCES

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APPENDIX A

MATERIALS AND METHODS - GEOLOGICAL DESCRIPTION OF CORES

A.1 MATERIALS

The following is a checklist of items and materials useful for the examination and description of sediment cores.

- ASTM Procedure D 2488-84
- Stainless-steel knife
- Hand lens (10X magnification)
- 10 N Hydrochloric acid (HCl)
- Ruler (scaled in 0.1-foot increments)
- Blank log forms (see Figure A-1)
- Clipboard
- AGI Data Sheets
- Munsell Color Charts

In addition, the charts and/or reference materials listed in Table A-1, and included in this appendix, are useful in the description of specific sediment characteristics.

A.2 METHODS

Descriptions of the physical, chemical, and biological features preserved in sediments aid in the interpretation of the types of geologic processes active both during and after the sediment was deposited. A total of 17 sediment characteristics, outlined in ASTM (1984), are commonly used to describe inorganic soils. These are listed in Table A-2.

Moisture condition was not routinely logged because of the saturated nature of the sediments. Furthermore, since particles were rarely larger than coarse sand, neither were angularity, particle shape, range in particle size, and hardness logged. For this reason, these sediment characteristics were not included in the log form for the description of the test

TABLE A-1. Charts and Other Reference Materials Used to Provide Standardized Descriptions of Sediment Characteristics

CHART/REFERENCE	PURPOSE	FIGURE #
• Roundness Scale	Roundness of sand and coarser particles	A-2a
• Percentage Estimate Chart	Estimate percentage of individual particles or constituents	A-3
• Particle Shape	Reference to describe particle shape	A-4
• Munsell Soil Color Charts	Soil color	A-5
• Unified Soil Classification System	Method for designating sediment type	A-6, A-7
• Grain-size Scales	Range of particle sizes; maximum particle size	A-8, A-9
• Sorting Chart	Estimate of grading	A-2b
• Lithologic Symbols	Graphic patterns for lithologic log	A-10, A-11

TABLE A-2. Sediment Characteristics Identified in ASTM Procedure D2488-84.

1) angularity *
2) particle shape *
3) color
4) odor
5) moisture condition
6) HCl reaction
7) consistency (i.e., firmness)
8) cementation *
9) structure
10) sediment classification type (i.e., lithology)
11) range of particle sizes*
12) maximum particle size
13) hardness *
14) dry strength **
15) dilatancy **
16) toughness **
17) plasticity **

* Applies to coarse-grained sediment (sand and larger particles)

** Applies to fine-grained sediment of mostly silt and/or clay

Features not generally logged for this study are underlined.

sediment (Figure A-1). However, in the few instances where these characteristics did apply, they were described under the "COMMENTS" column.

The definition of "soil" from the engineers standpoint (ASTM, 1984), includes any unconsolidated sediment. The geologic definition of soil is slightly different and restricts soils to those sedimentary deposits that have undergone alteration near the land's surface by either physical, chemical, and/or biological processes; therefore, in a strict sense, not all sediments are soils. For the purposes of this discussion, however, "soils" and "sediments" will be used synonymously.

It is sometimes helpful to provide an estimate of the relative proportions of different constituents in sediments (e.g. light- versus dark-colored minerals). This is made easier and more accurate by using a percentage estimate chart, which provides a graphic reference with varying concentrations of a particular constituent (Fig. A-2).

The criteria used to describe each of the 17 sediment characteristics identified in ASTM (1984) are discussed below.

A.2.1 Angularity

The angularity of sedimentary particles is a reflection of the sedimentary environment and the amount of time that has elapsed before deposition and burial. A chart showing how to to classify the angularity of sedimentary particles is presented in Figure A-3a. A range of angularity may be stated, such as: subrounded to rounded.

A.2.2 Shape

Shapes of sedimentary particles often reflect the internal characteristics (e.g., preferential parting) of the material or sometimes the type of sedimentary environment. For example gravel clasts deposited in high-energy environments, such as beaches and river bottoms, are often worn flat.

According to Figure A-4, gravel-sized clasts may be described in one of four ways. First, if the ratio of the clast's width to thickness is >3, it is classified as flat. Second, if the ratio of the clast's length to

Core #:
Date:
Page ___ of ___

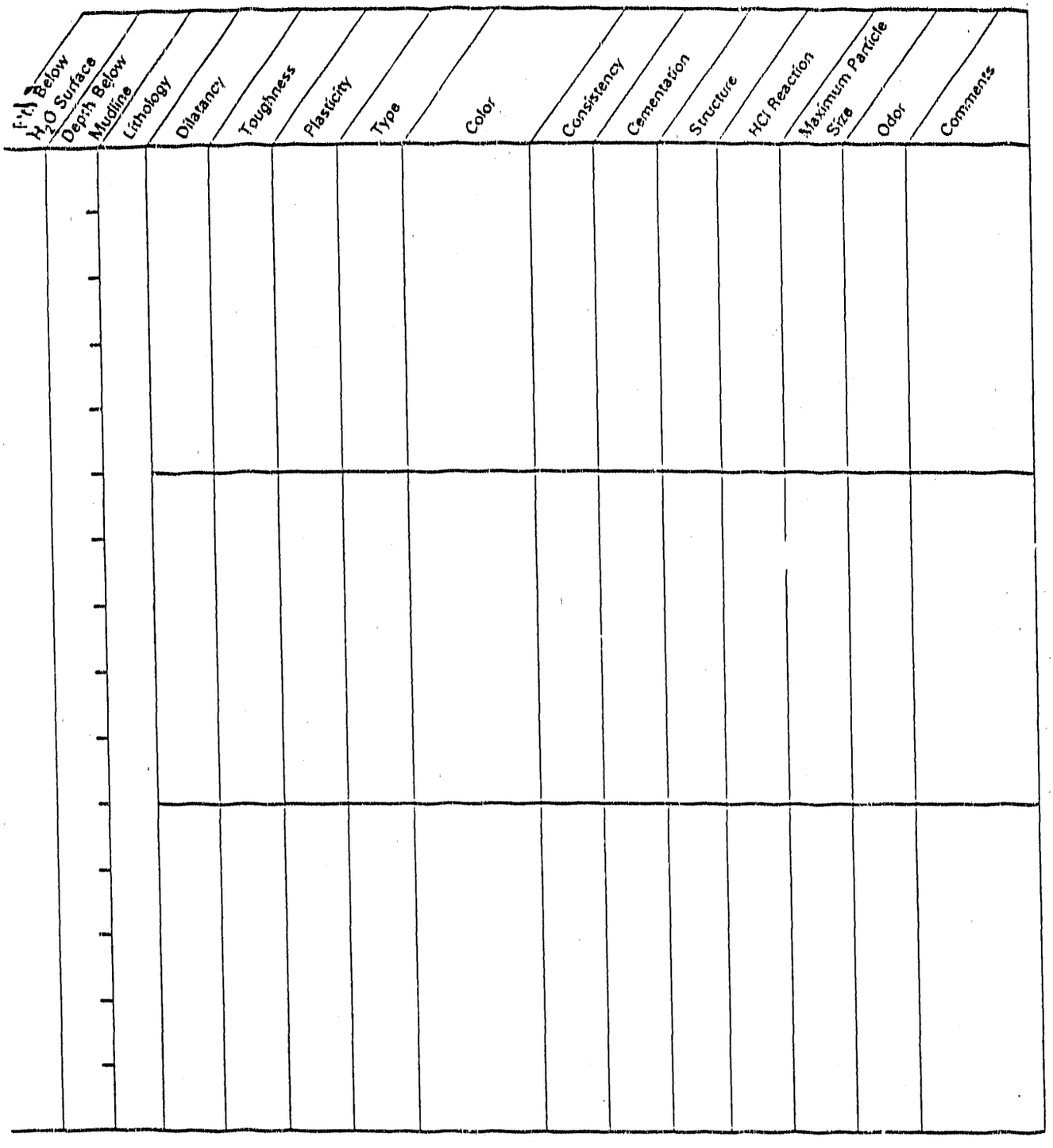


Figure A-1. Log Form Used to Record Sediment Descriptions

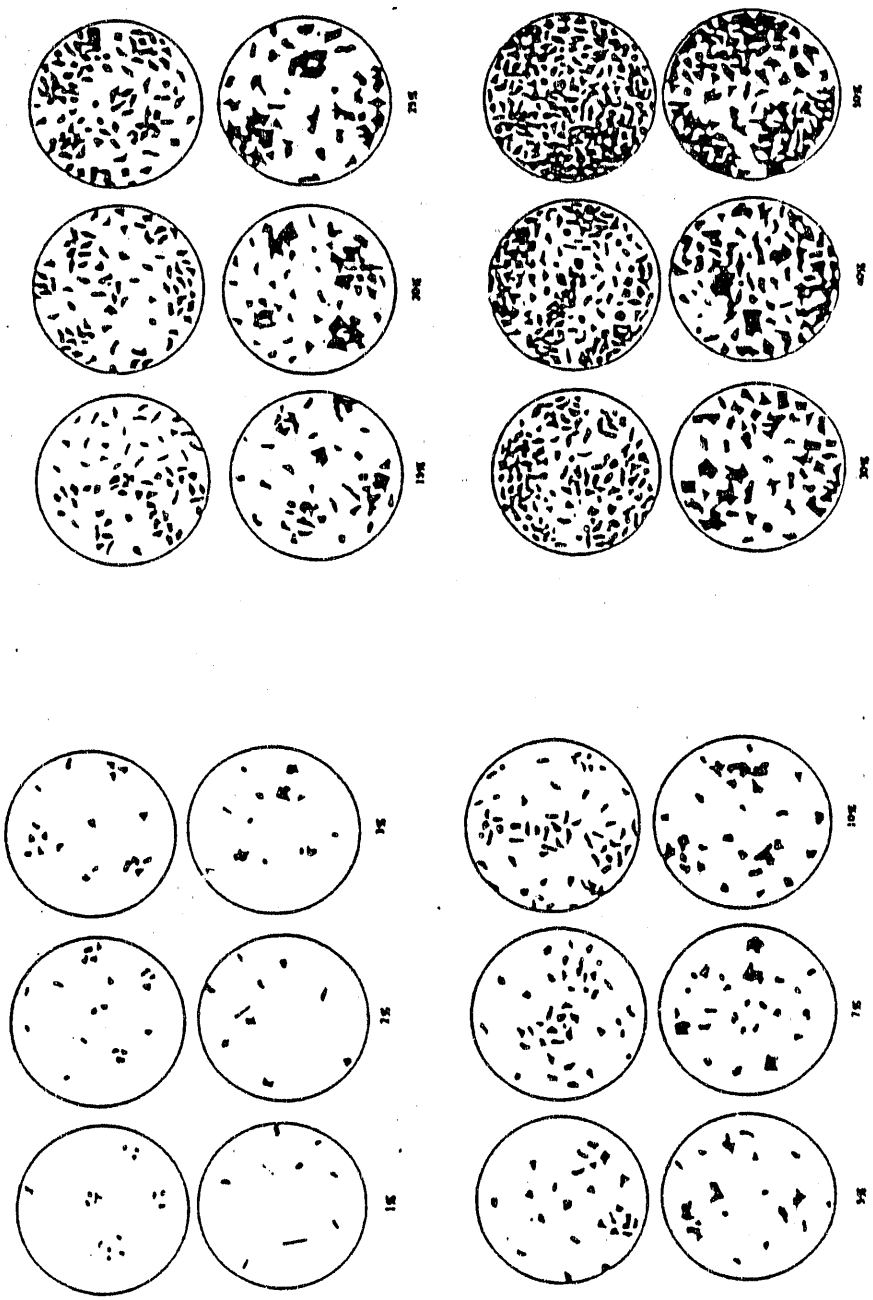
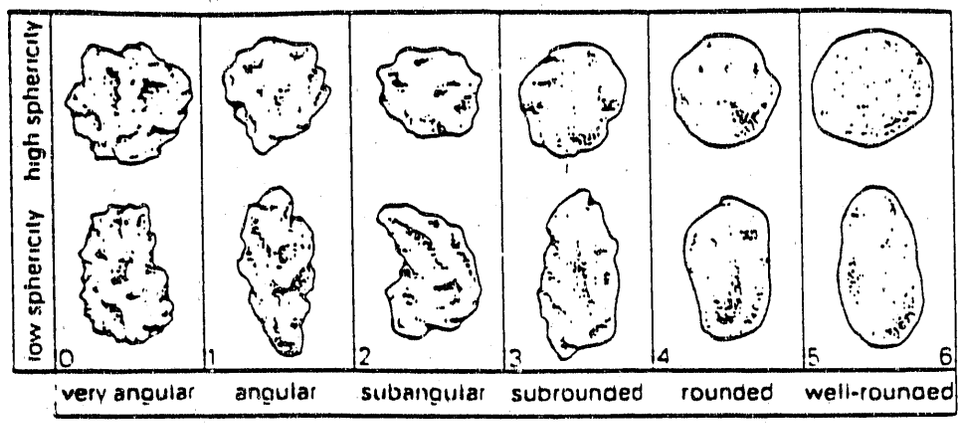


Figure A-2. Percentage Estimate Chart

A



B

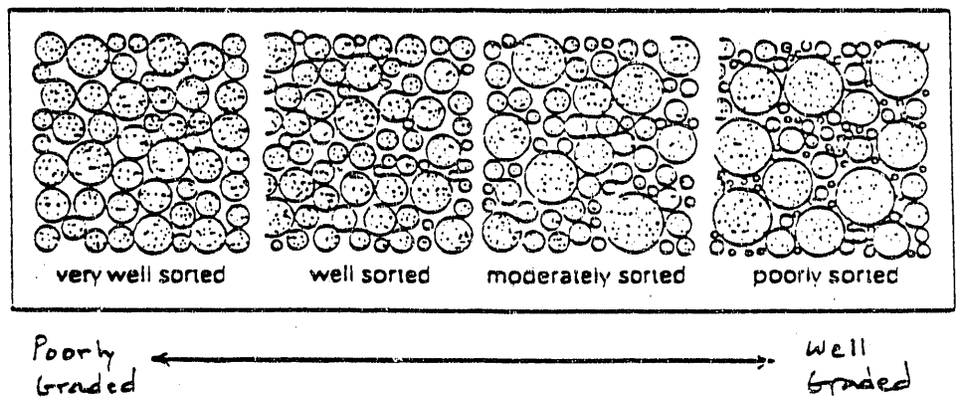
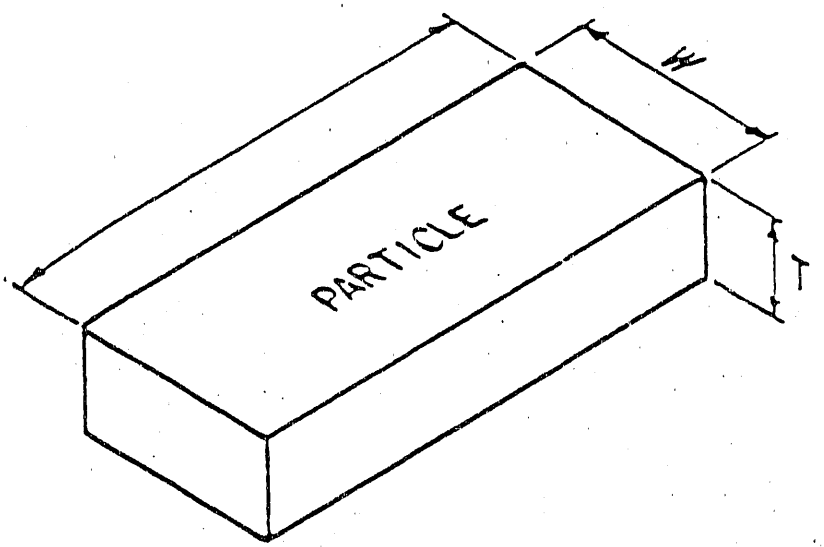


Figure A-3. Charts Used to Visually Estimate Roundness/Sphericity (A) and Sorting/Grading (B)

PARTICLE SHAPE

W = WIDTH
T = THICKNESS
L = LENGTH



FLAT: W/T > 3
ELONGATED: L/W > 3
FLAT AND ELONGATED:
- meets both criteria

Figure A-4. Criteria used to Describe Particle Shape From ASTM (1984)

width is >3, the clast is elongate. Third, if both criteria apply the clast is both flat and elongate. And last, if none of the criteria apply, then shape is not mentioned. Indicate the fraction of the clasts that have the shape, such as: one-third of gravel clasts are flat. Particle shape did not apply to most of the sediments logged during this project and the few pebbles that were observed were neither flat nor elongate.

A.2.3 Color

Color may be useful in identifying materials of similar geologic origin. For example, color was often a useful criteria for differentiating Younger Bay Mud from Older Bay Mud. Sediment color was determined by comparing the wet sediment with standard sediment colors given in Munsell (1975). The advantage to using the Munsell soil color system is that it provides a consistent, standardized method for describing color and subjectivity is minimized.

The Munsell color notation consists of three simple variables that combine to describe all colors known in the Munsell soil color system. The three variables are: hue, value, and chroma (Figure A-5). The hue notation indicates the relation of the sediment color with respect to red, yellow, green, blue and purple; the value notation indicates its lightness, and the chroma notation indicates its strength (i.e., intensity).

Color can be described either by the Munsell notation (e.g. 5YR 5/3; hue=5YR, value=5, chroma=3) or by its equivalent color name (e.g. reddish brown). Both the color name and Munsell notation were recorded on core logs. Only rarely was there not a reasonable match between the true color of the core sediment and one of the colors on a Munsell color chart.

A.2.4 Odor

Odors may indicate the presence of contaminants or be the result of the geochemical environment. Odors most frequently noted were that of petroleum hydrocarbons and the smell of rotten eggs (an indication of the presence of hydrogen sulfide). Both of these odors were restricted to the Younger Bay Mud unit. Petroleum odors may be the result of contamination of the

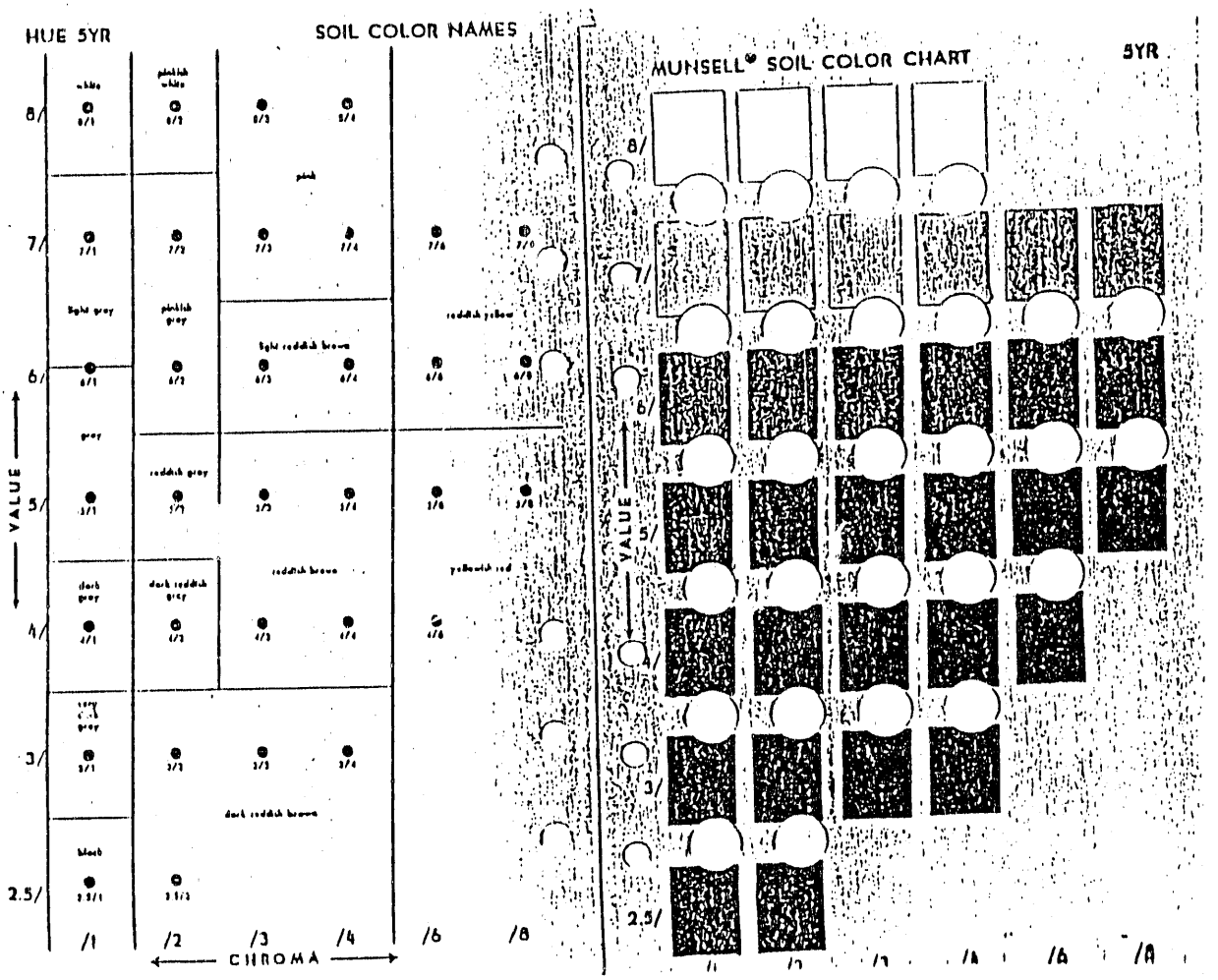


Figure A-5. Example of a Page From the Munsell Soil Color Chart for Hue 5YR. Color Chips Used to Estimate Soil Color Are on the Right

sediments by shipping spills or industrial waste, or perhaps is derived fromthe abundant decaying organic matter present in these sediments. Hydrogen sulfide is a common natural by-product in chemically reducing environments such as the urbanized estuaries.

A.2.5 Moisture Condition

Moisture condition is described as either dry, moist, or wet according to the following criteria:

DRY	Absence of moisture, dry to the touch
MOIST	Damp but no visible water
WET	Visible free water, usually soil is below water table (i.e., saturated)

All the sediments logged for this project were taken from below sea level and did not lose any significant moisture between the time they were drilled and logged. Therefore, they are all classified as wet.

A.2.6 HCl Reaction

The reaction (i.e., effervescence) of sedimentary material, as a result of adding dilute hydrochloric acid, is an indication of the presence of calcium carbonate. Calcium carbonate in sediments may be derived from a variety of sources including: 1) physical disintegration of preexisting carbonate rocks (e.g., limestone, marble), 2) biogenic precipitation (e.g., shell, bone), and 3) soil development. In the last example, calcium carbonate concentrations, often referred to as caliche or calcrete, may accumulate over time near the land's surface in arid climates. Where calcium carbonate concentrations occur in combination with other evidence for soil development, such as root traces and oxidation, then a pedogenic (soil forming) origin is favored. Criteria for describing the reaction with 10 N HCl are as follows:

NONE	No visible reaction
WEAK	Some reaction, with bubbles forming slowly
STRONG	Violent reaction, with bubbles forming immediately

A solution of 10 N HCl is obtained by slowly adding one part of concentrated hydrochloric acid to three parts of distilled water. (To avoid

a violent exothermic reaction never add water to acid).

A.2.7 Consistency

Consistency is a measure of the firmness or consolidation of sedimentary material. In general, there is a direct relationship between consistency and age of the deposit (i.e., older deposits are usually more firm because of compaction and/or cementation). Consistency is most applicable to fine-grained sediments and least applicable on sediments that contain significant amounts of gravel. The criteria used to determine consistency are as follows:

VERY SOFT	Thumb will penetrate soil more than 1 inch (25 mm)
SOFT	Thumb will penetrate soil about 1 inch (25 mm)
FIRM	Thumb will indent soil about 1/4 inch (6 mm)
HARD	Thumb will not indent soil but readily is readily indented with thumbnail
VERY HARD	Thumbnail will not indent soil

A.2.8 Cementation

Often sedimentary particles are held together with a binding cement. Three common natural cements are calcium carbonate (lime), silica, and iron-oxide compounds. Particles cemented with calcium carbonate effervesce in the presence of hydrochloric acid (see Section A.2.6 above). Sediments cemented with iron oxide are usually some shade of red, yellow, or brown. Usually there is a relationship between consistency (Section A.2.7) and cementation, in that strongly cemented deposits are also hard to very hard. Criteria used to describe the degree of cementation are:

WEAK	Crumbles or breaks with handling or light finger pressure
MODERATE	Crumbles or breaks with considerable finger pressure
STRONG	Will not crumble or break with finger pressure

A.2.9 Structure

Structures are features that originate within the layers of sediment or at the sediment/water interface in response to various physical, biologic and/or chemical processes. Structures may be classified into two categories: primary and secondary. Primary structures form as the sediment is being deposited (e.g., lamination, stratification). Secondary structures form after deposition, often as a result of compaction or other stresses (e.g., fissured,), biologic activity (e.g., root traces, mottling), and soil development (e.g., homogeneous, blocky, mottled). The following are some common structures observed in sedimentary deposits.

PRIMARY STRUCTURES

STRATIFIED	Alternating layers of varying material or color with layers at least 6 mm thick
LAMINATED	Alternating layers of varying material or color with the layers less than 6 mm thick
LENSED	Inclusion of small pockets of different sediment type, such as small lenses of sand scattered through a mass of clay. (This type of structure may also be secondary).

SECONDARY STRUCTURES

FISSURED	Breaks along definite planes of fracture with little resistance to fracturing
SLICKENSIDED	Fracture planes appear polished or glossy, sometimes striated
BLOCKY	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
MOTTLED	Variation in color of sediments as represented by localized spots or blotches of color or shades of color
HOMOGENEOUS	Same color and appearance throughout

A.2.10 Sediment Classification Type

The classification method used in this study is the Unified Soil Classification System (Fig. A-6), which consists of a two-letter designation for most soils (i.e., unconsolidated sediments). A simplified version of the

MAJOR DIVISIONS			GROUP SYMBOLS	DESCRIPTION
COARSE-GRAINED SEDIMENTS (More than half of particles are larger than very fine sand)	≥ 50% GRAVEL	Clean gravels	GW	Well-graded (i.e., poorly sorted) gravels, gravel-sand mixtures, little or no fines
			GP	Poorly graded (i.e., well sorted) gravels, gravel-sand mixtures, little or no fines
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	≥ 50% SAND	Clean sands	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands, gravelly sands, little or no fines
		Sands with fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SEDIMENTS (More than half of particles are smaller than very fine sand)	SILTS AND CLAYS	Low liquid limit	ML	Silts and very fine sands, silty or clayey fine sands, or clayey silts, with slight plasticity
			CL	Clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		High liquid limit	MH	Silts or fine sandy silts with moderate plasticity
			CH	Clays of high plasticity, fat clays

Figure A-6. Abbreviated Form of the Unified Soil Classification System. From AGI (1982)

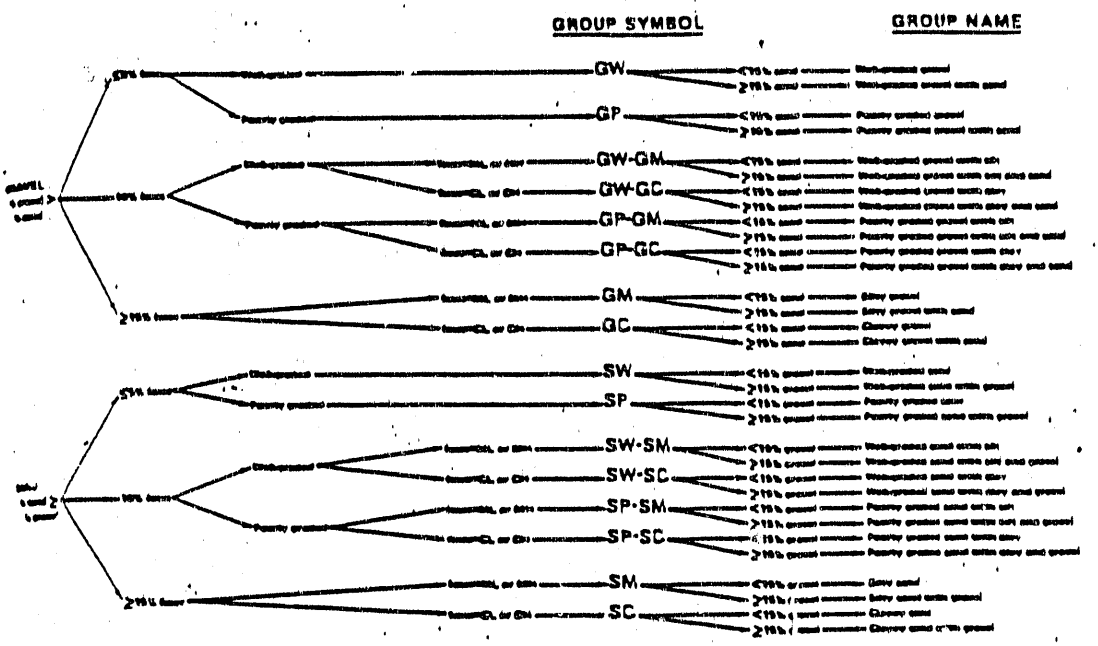
Unified Soil Classification System is presented in Figure A-6, while a more-detailed breakdown is presented in Figure A-7. According to this classification system, coarse-grained sediments are classified based on grain-size distribution and grading (i.e., sorting), while fine-grained sediments are classified on the basis of grain size and liquid limit vs. plasticity.

Particle-size distribution may be determined with precision using laboratory methods (e.g., sieving of sand and coarser particles; pipette or hydrometer analysis of silt and clay). Because these methods are expensive and time-consuming, it is more desirable to estimate grain size using rapid visual-manual techniques described below. For example, sand and coarser particles are most easily identified via comparison with standard charts of grain size (Figs. A-8 and A-9). Fine-grained soils, consisting of mostly silt and/or clay, on the other hand, are identified based on manual tests of their dry strength, dilatancy, toughness, and plasticity (Figure A-10).

In the Unified Soil Classification System (Figs. 6 and 7), the first letter of the sediment-type symbol represents the predominant grain-size interval, be it gravel (G), sand (S), silt (M), or clay (C). For coarse-grained sediments, the first letter (i.e., G or S) may be followed by a descriptor of grading, either W (well graded) or P (poorly graded), or a secondary grain-size descriptor (M or C). The definition of grading is opposite that of sorting, a common geologic term. For example, a clean, well-sorted sand, consisting of particles over a narrow range in grain size, is referred to as poorly graded in the Unified Soil Classification System and would receive the designation "SP". The relationship between grading and sorting is shown graphically in Figure A-3b. The second letter in the fine-grained soil designation consists of either L (low liquid limit) or H (high liquid limit).

The lithology column on the geologic log (Fig. A-1) essentially represents a graphic display of sediment type. The graphic displays of lithology are utilized for quick easy reference and comparison between different cores and thus make interpretations easier. The symbols used for the collected sediments are shown in Fig A-11. Examples of other

A



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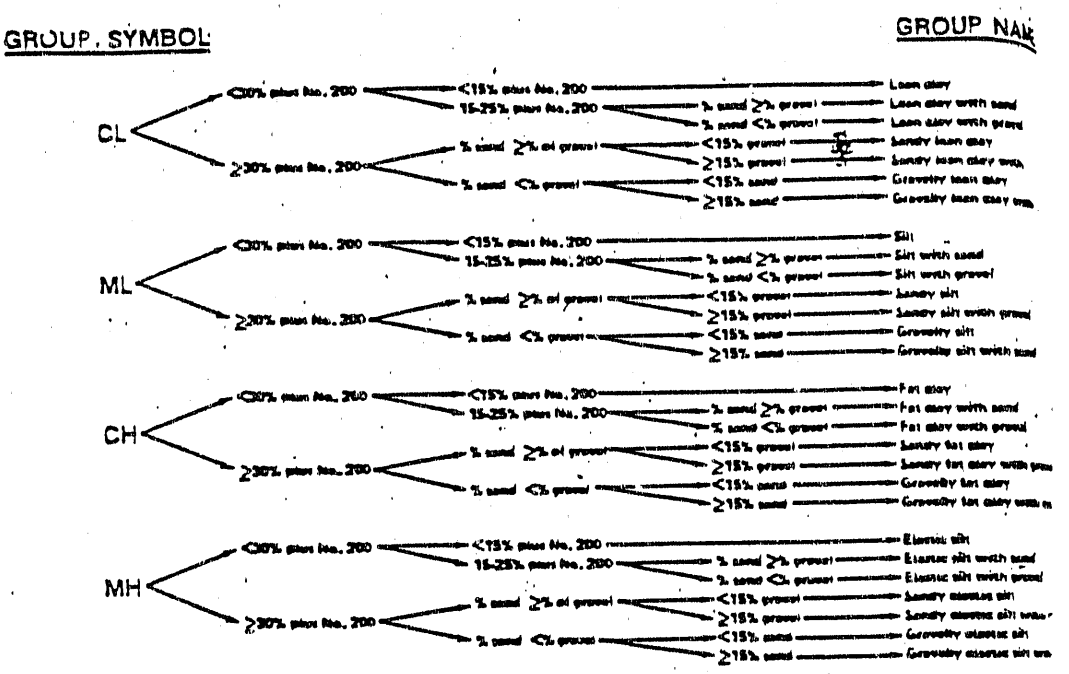

Figure A-7. Detailed Flow Chart For the Classification of Coarse-grained (A) and Fine-grained (B) Soils Using the Unified Soil Classification System

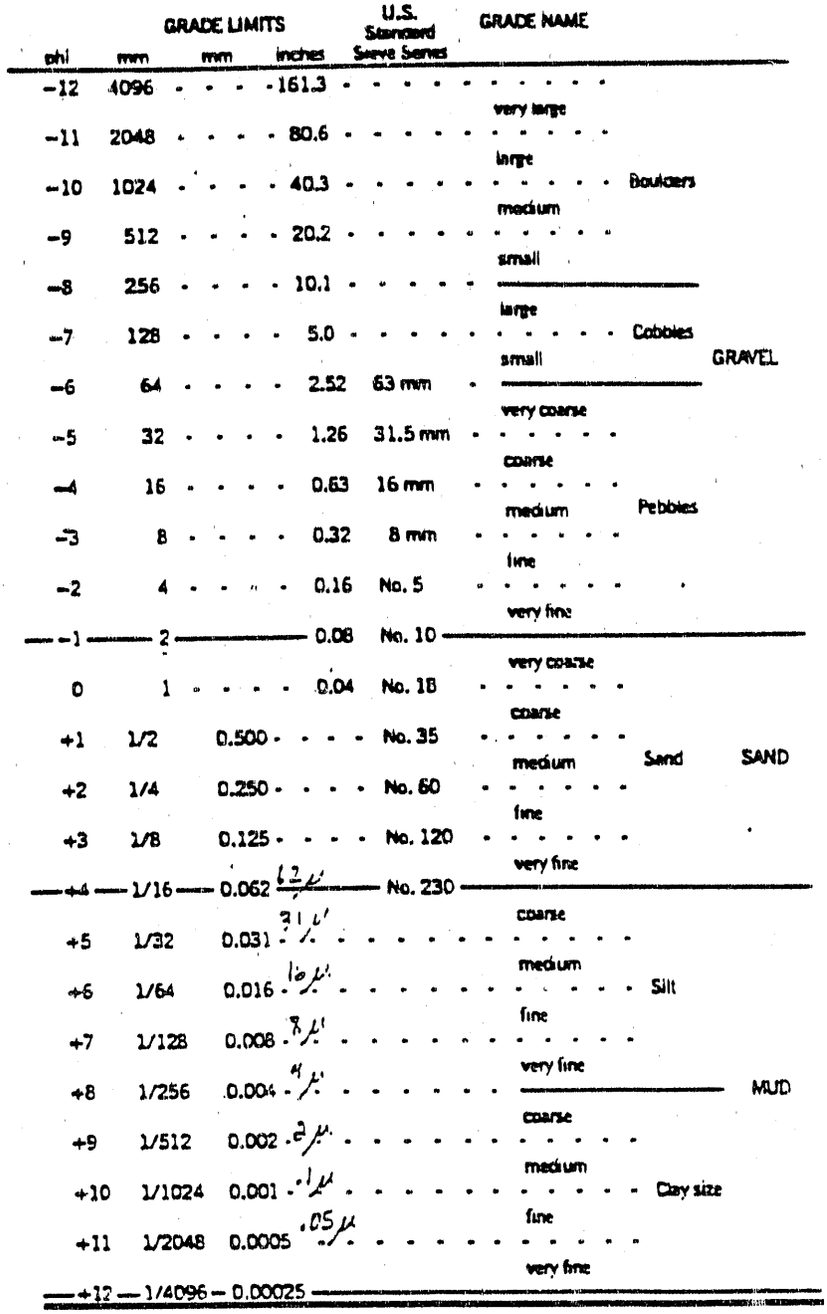

Figure A-8. Grain-size Scales Used to Determine Sedimentary Particle Size

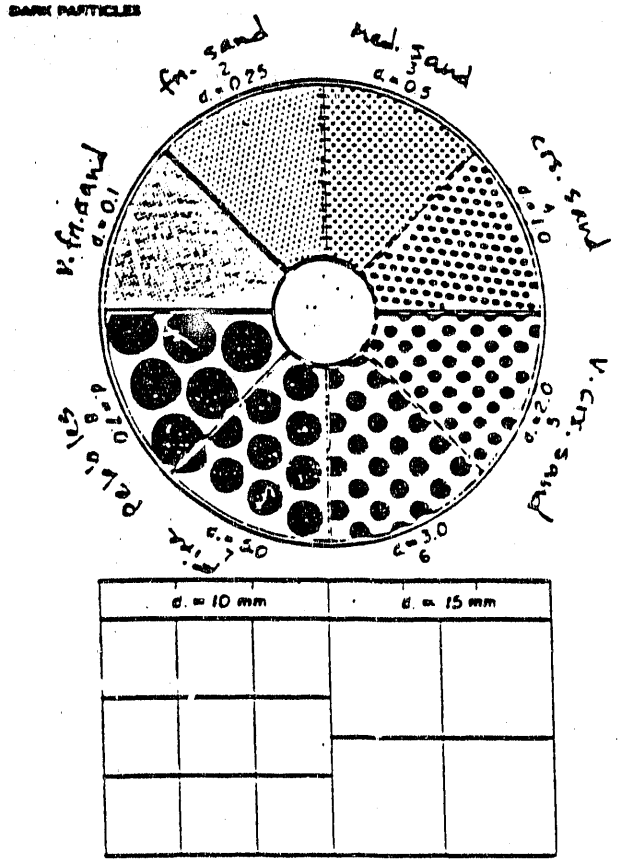

Figure A-9. Comparison Chart Used to Distinguish Among Sand to Pebble-size Particles. From AGI (1982). For larger particles, refer to Figure A-8; for smaller particles, refer to sections A.2.13 and A.2.16 in this Appendix

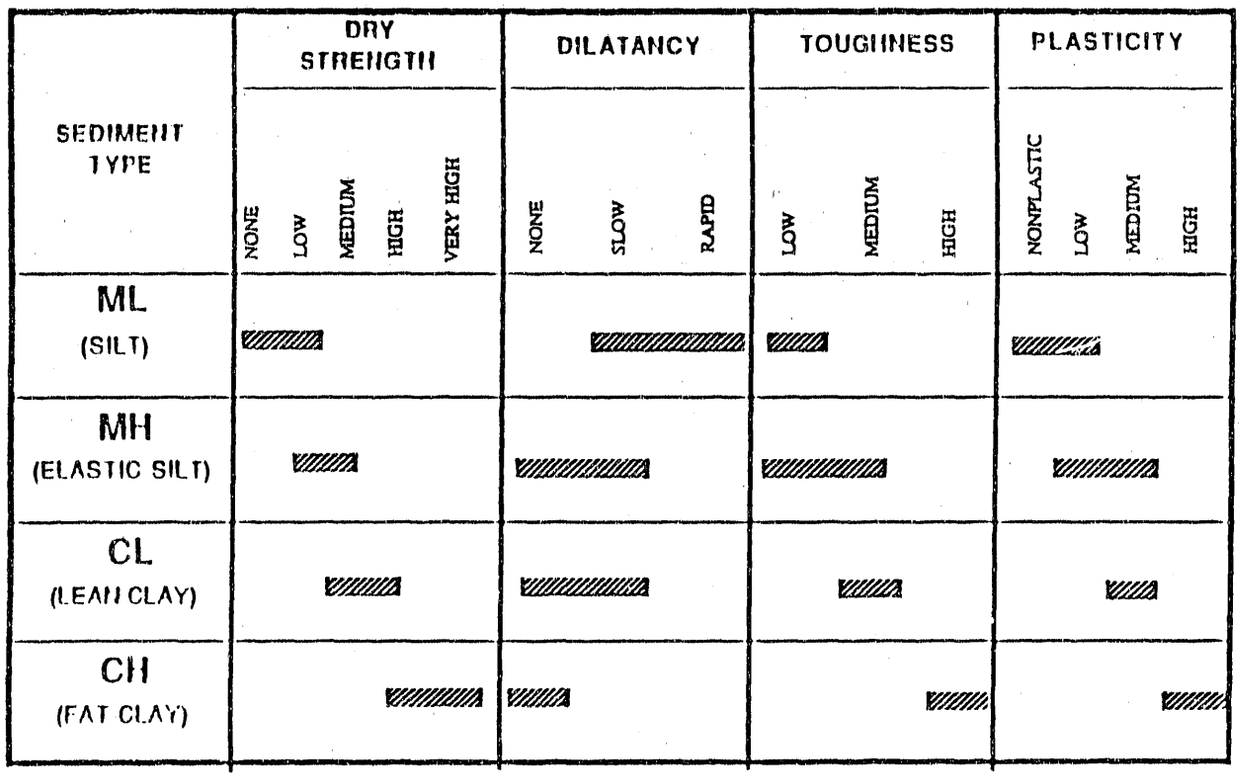

Figure A-10. Identification of Inorganic Fine-grained Soils From Manual Tests

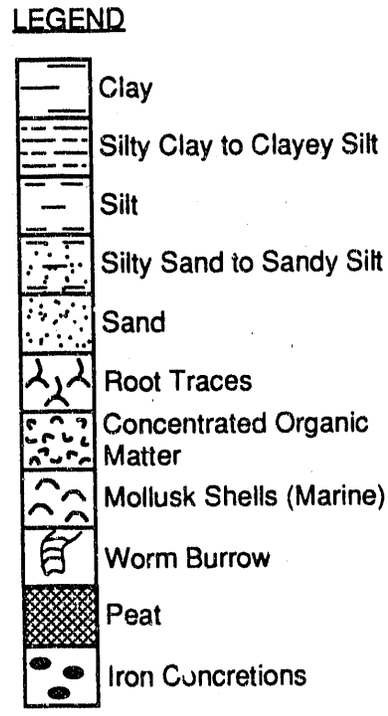

Figure A-11. Symbols Used to Represent Different Lithologic Properties on Core Logs

lithologic symbols in common use are presented in Fig. A-12. Additional symbols may be used as long as they are graphically representative of the feature and are specifically defined and identified in a key that accompanies lithologic logs.

A.2.11 Range of Particle Sizes

For gravel- and sand-sized particles, the range of particle sizes within each component is defined. For example, 20% fine to coarse gravel, 40% fine to coarse sand. The sizes of particles corresponding to the different size components are presented in Figures A-8 and A-9.

A.2.12 Maximum Particle Size

Maximum particle size is significant because it gives a general indication of the amount of turbulence or energy associated with deposition. If the maximum particle size is sand, it should be described as either fine, medium, or coarse sand. If the maximum particle size is in the gravel range, the largest particle is measured and its width recorded along the narrowest axis. The sizes of particles corresponding to the different size components are presented in Figures A-8 and A-9.

The maximum grain size observed for the Younger Bay Muds ranged from silt to medium sand, while the Older Bay Mud usually ranged from fine sand to coarse sand. The largest particles observed anywhere were fine pebbles in the Older Bay Mud unit.

A.2.13 Dry Strength

Dry strength, along with dilatancy, toughness, and plasticity are physical characteristics used to distinguish fine-grained inorganic soils, consisting of mostly silt and/or clay. Basically, the more clay present in a soil the greater its dry strength (Fig. A-10). To perform a manual test of dry strength enough material must be selected in order to mold into a ball about 1 in. in diameter. Mold the material until it has the consistency of putty, adding water if necessary. From the molded material, make at least three test specimens each about 1/2 in. in diameter. Allow the test specimens to dry in air, sun or by artificial means, as long as the

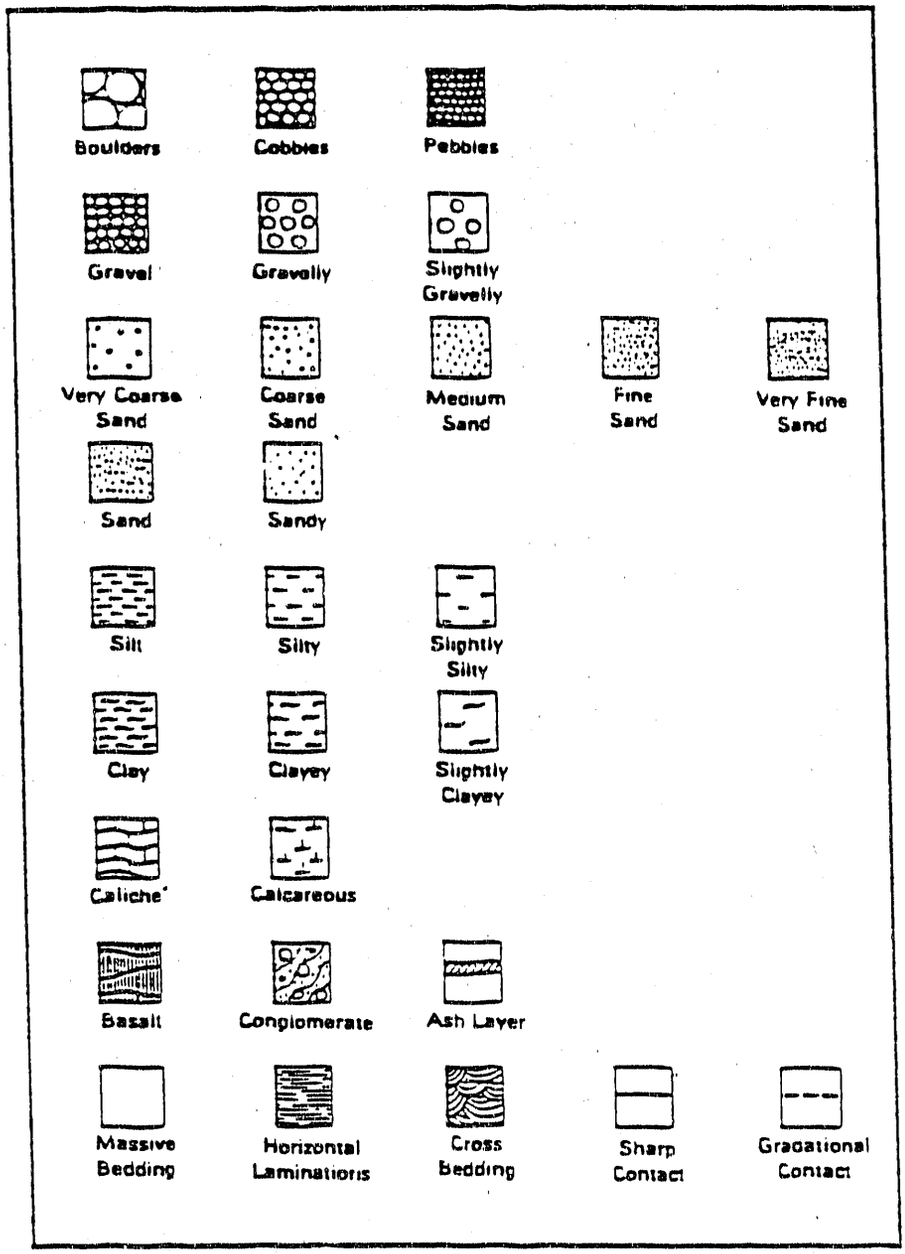

Figure A-12. Additional Lithologic Symbols in Common Use

temperature does not exceed 60°C (ASTM, 1984). The criteria for determining dry strength are as follows:

NONE	The dry specimen crumbles into powder with mere pressure of handling
LOW	The dry specimen crumbles into powder with light finger pressure
MEDIUM	The dry specimen breaks into pieces or crumbles with considerable finger pressure
HIGH	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
VERY HIGH	The dry specimen cannot be broken between the thumb and a hard surface

Dry strength was determined for the sediment cores by sampling selected intervals and allowing the samples to air dry overnight. Dry strength was determined the next day and noted in the comments column of the geologic log.

A.2.14 Dilatancy

Dilatancy is a measure of how easily a soil gives up water when shaken. For example, some clays have the ability to absorb and retain large amounts of water into their crystal lattice. "Fat" clays tend to retain their water even under stress whereas "lean" clays and silt tend to release water when shaken.

To test for dilatancy select enough material to mold into a ball about 1/2 in. in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky consistency. Smooth the soil ball in the palm of the hand with a blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction. Specimens with high dilatancy will quickly yield water when shaken and absorb water when squeezed. The criteria for describing dilatancy are:

NONE — No visible change in the specimen

SLOW — Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing

RAPID — Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

The range of dilatancy for the different fine-grained sediment types is shown in Figure A-10. From this figure it is apparent that dilatancy decreases with decreasing grain size.

A.2.15 Toughness

After completion of the dilatancy test, shape the same specimen into an elongated pat and roll by hand on a smooth surface or between the palms into a thread about 1/8 in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about 1/8 in. The thread will crumble at a diameter of 1/8 in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading and classify into one of the following categories.

LOW — Only slight pressure is required to roll the thread near the plastic limit. The thread and lump are weak and soft.

MEDIUM — Medium pressure is required to roll the thread to near the plastic limit. The thread and lump have medium stiffness.

HIGH — Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

The range of toughness for the different fine-grained sediment types is shown in Figure A-10. From this figure it is apparent that toughness increases with a decrease in particle size.

A.2.16 Plasticity

On the basis of observations made during the toughness test, describe the plasticity of the material according to the following criteria:

NONPLASTIC	A 1/8 in. thread cannot be rolled at any water content.
LOW	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
MEDIUM	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
HIGH	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

The range of plasticity for the different fine-grained sediment types is shown in Figure A-10. From this figure it is apparent that an increase in plasticity accompanies a decrease in grain size.

A.3 REFERENCES

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Last, G.V., and Liikala, T.L., 1987, A field guide for well-site geologists: cable-tool drilling: PNL-6392, Battelle, Pacific Northwest Laboratory, Richland, Washington.

Munsell, 1975, Munsell Soil Color Charts: Macbeth, a division of Kollmorgen Co., Baltimore, Maryland, 7 charts.

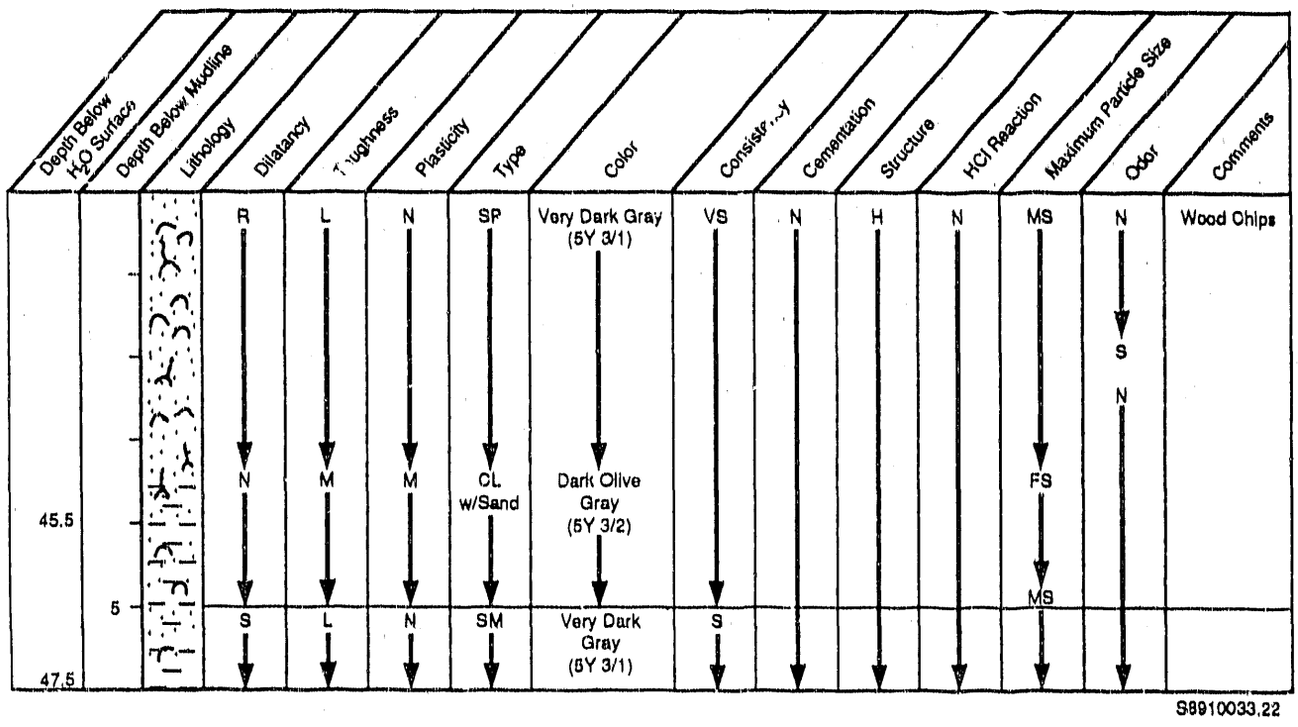
Tucker, M. E., 1982, The field description of sedimentary rocks: John Wiley and Sons, New York, 112 p.

APPENDIX B

JOHN F. BALDWIN SHIP CHANNEL CORE LOGS

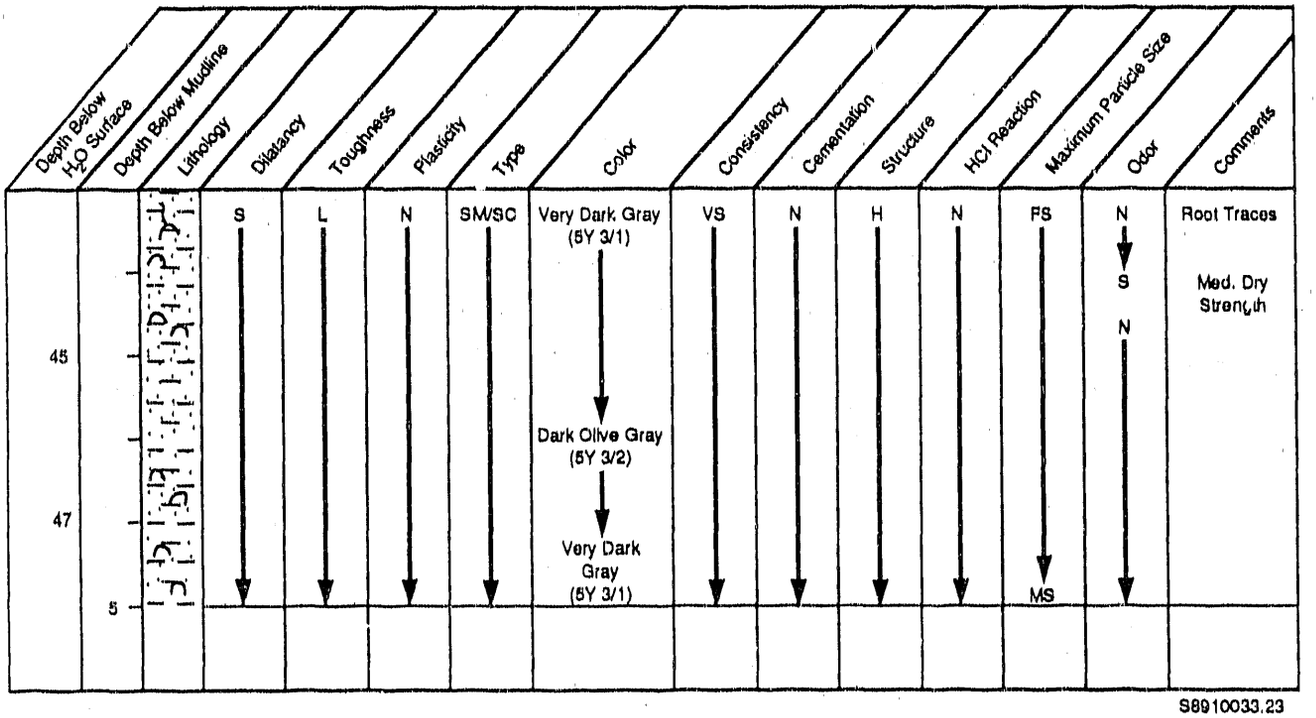
Core#: WR VII C
Date: 9-14-89
Page 1 of 1

Mudline = 41.5' MLLW
Core Length = 6'



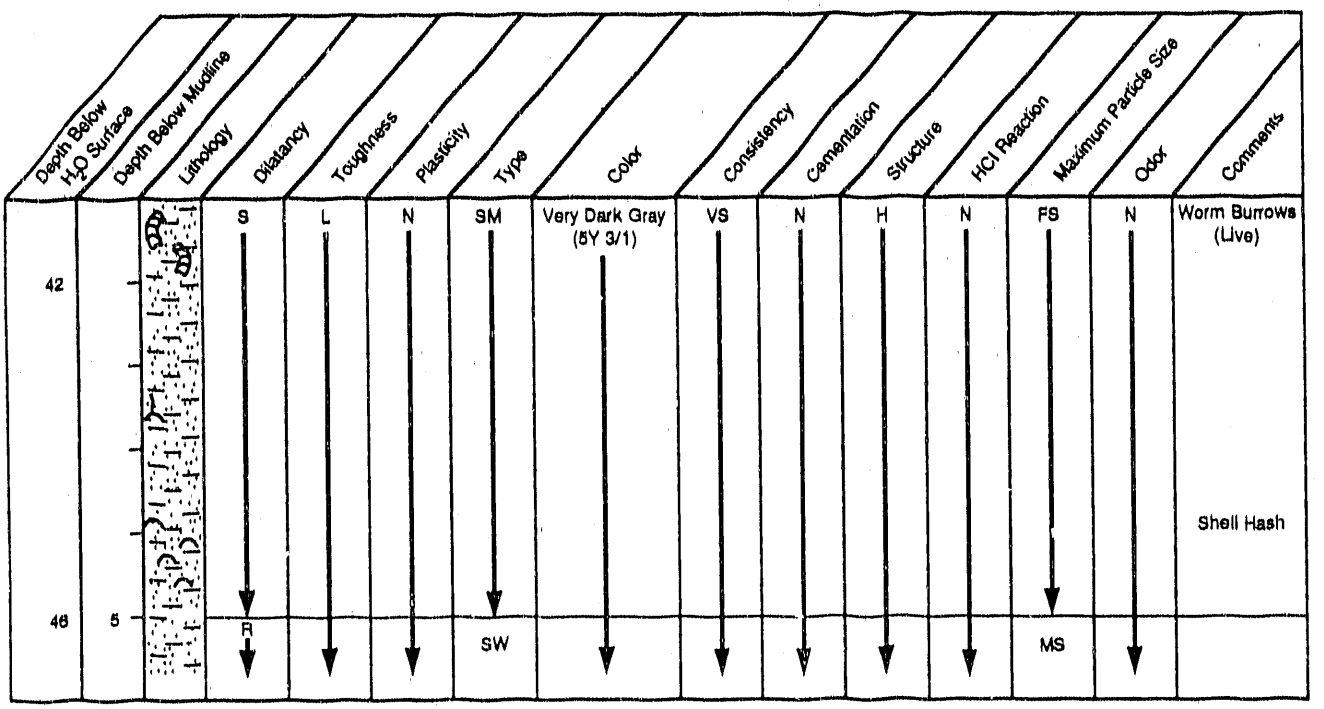
Core#: WR VI L
Date: 9-14-89
Page 1 of 1

Mudline = 43' MLLW
Core Length = 0' - 5'



Core#: WR V L
Date: 9-14-89
Page 1 of 1

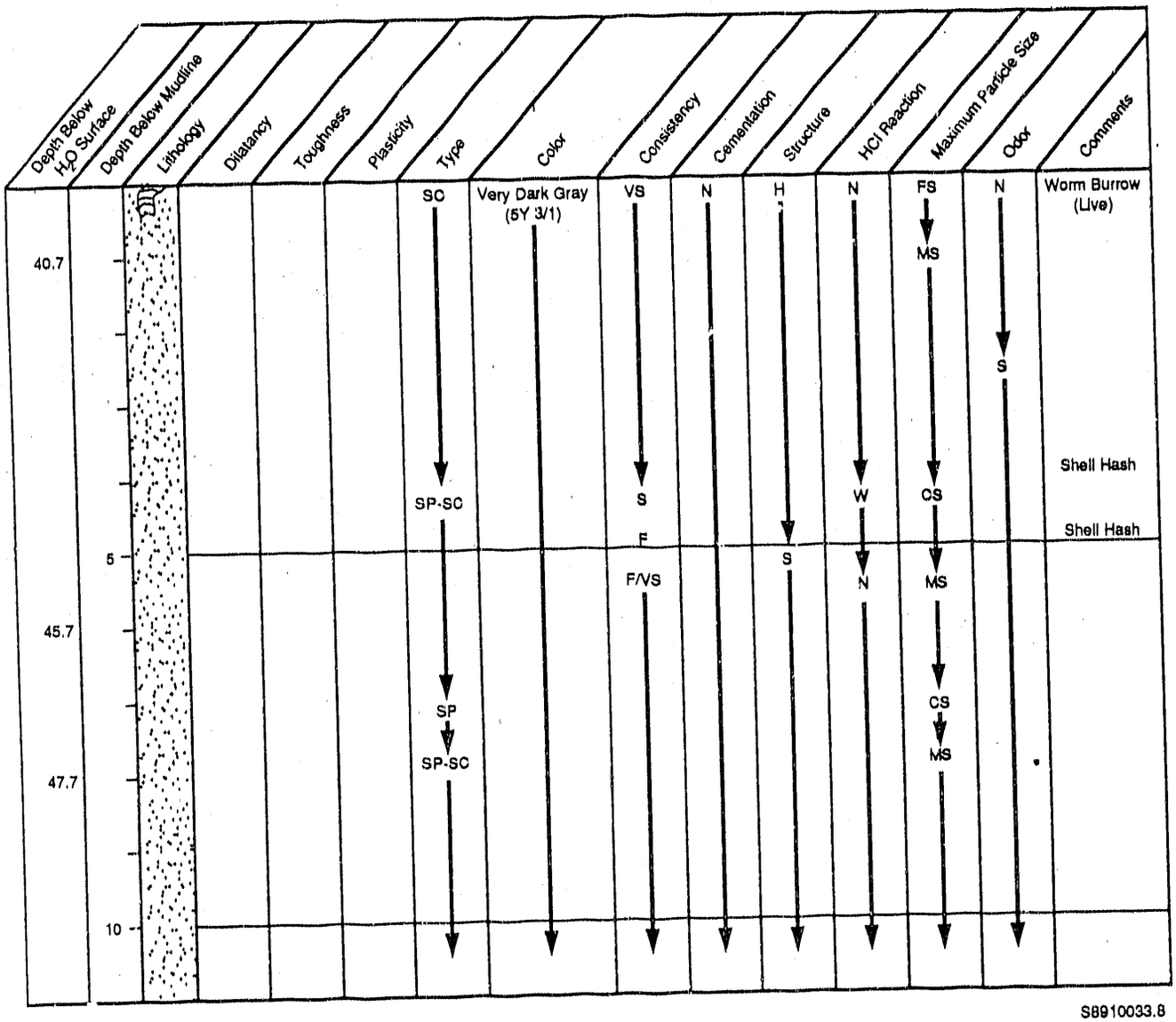
Mudline = 41.0' MLLW
Core Length = 5' 8-1/2"



S8910033.24

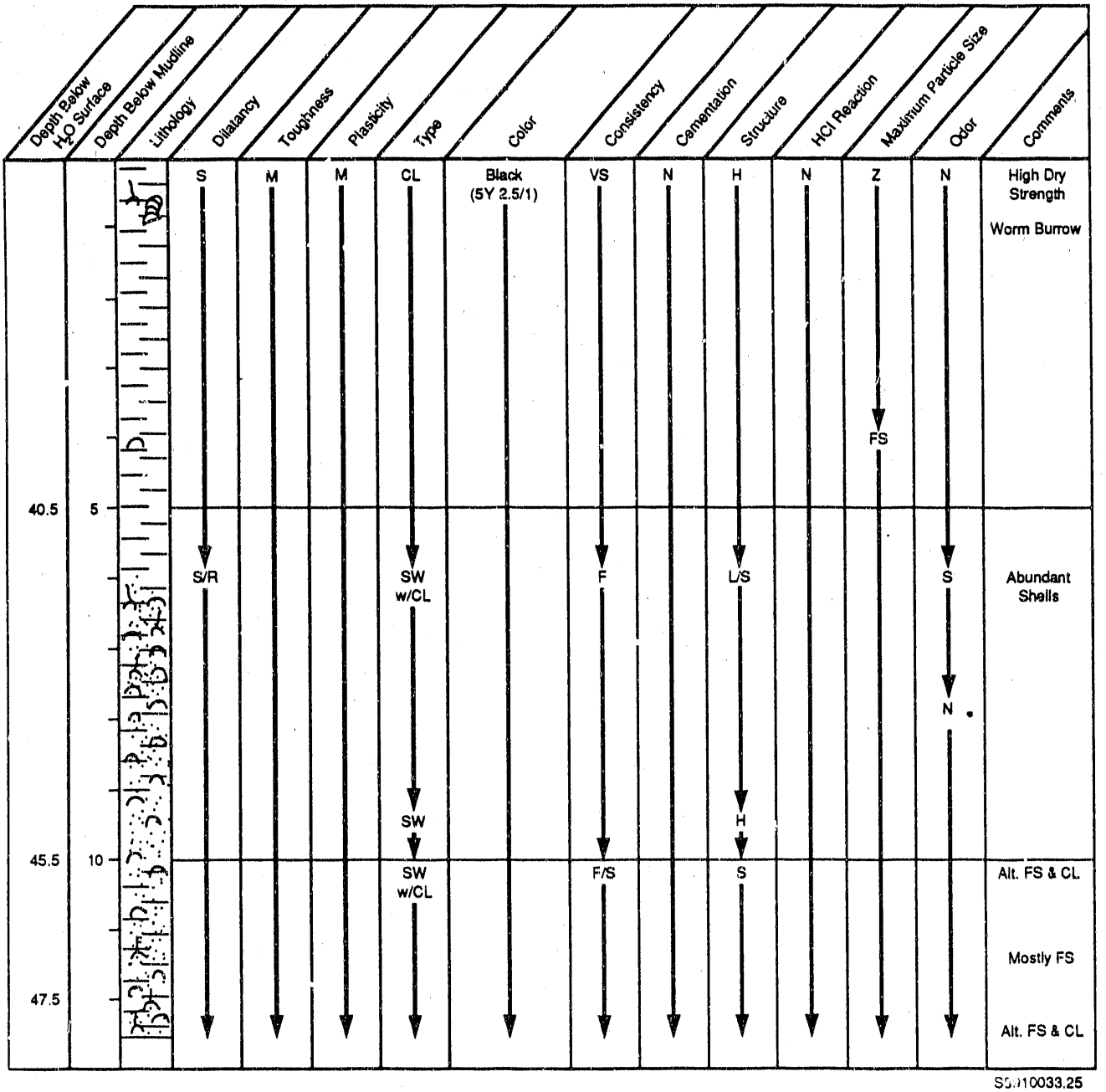
Core#: WR IV .5 C
Date: 9-14-89
Page 1 of 1

Mudline = 39.7' MLLW
Core Length = 0' - 5'2-1/2"
5'2-1/2" - 10'4-1/2"



Core#: WR IV R
Date: 9-19-89
Page 1 of 1

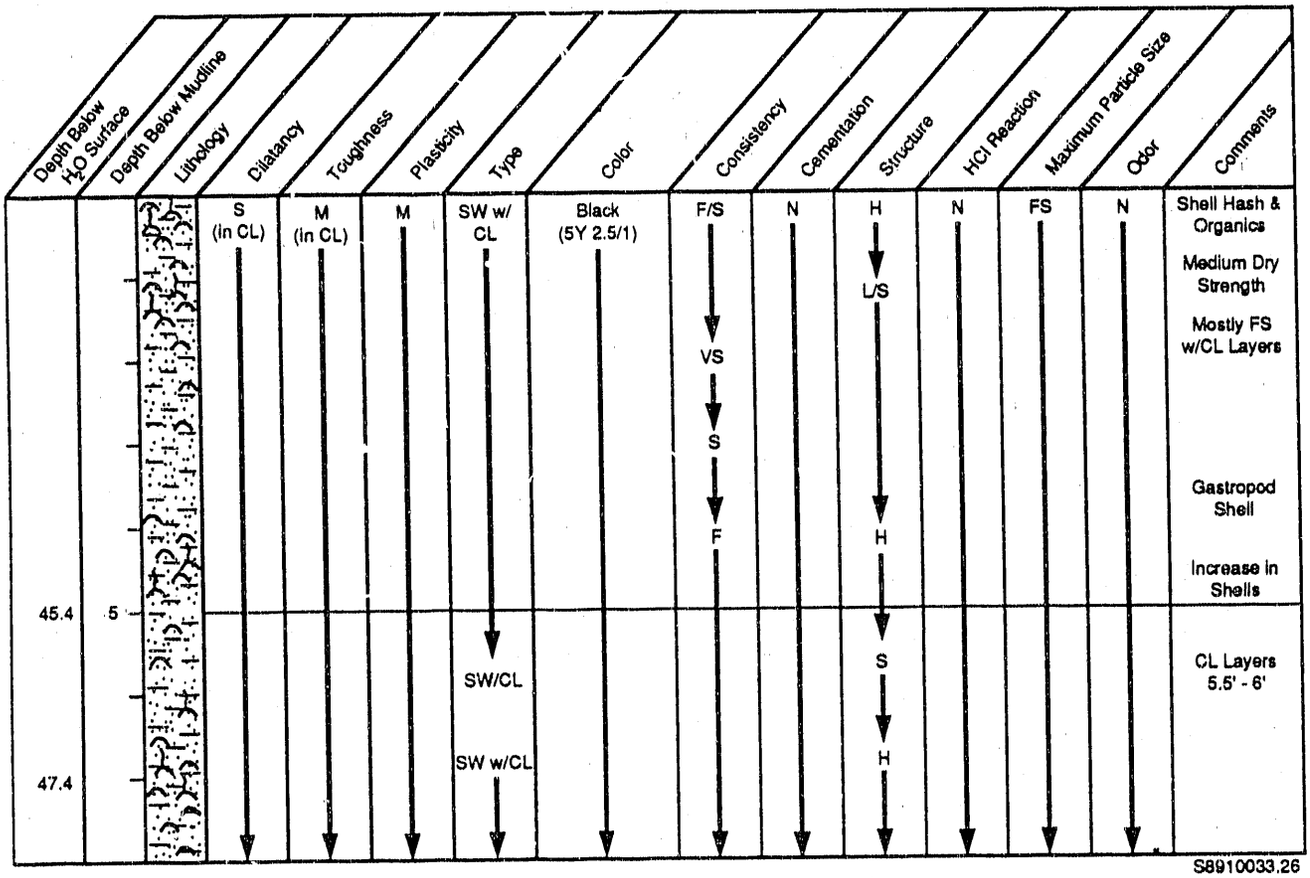
Mudline = 35.5' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 12.6'



S0010033.25

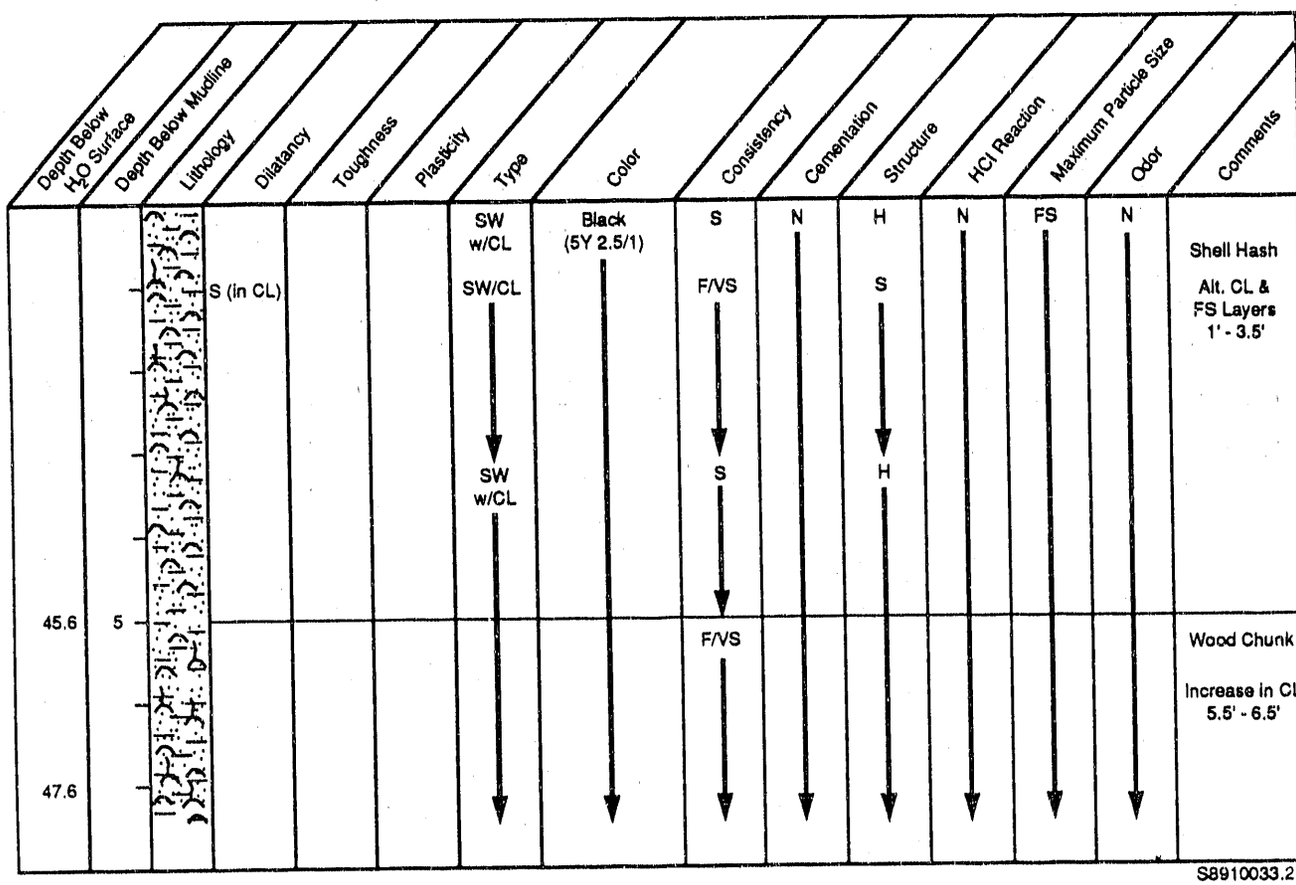
Core#: WR III L
Date: 9-19-89
Page 1 of 1

Mudline = 40.4' MLLW
Core Length = 0 - 5'
5' - 8'



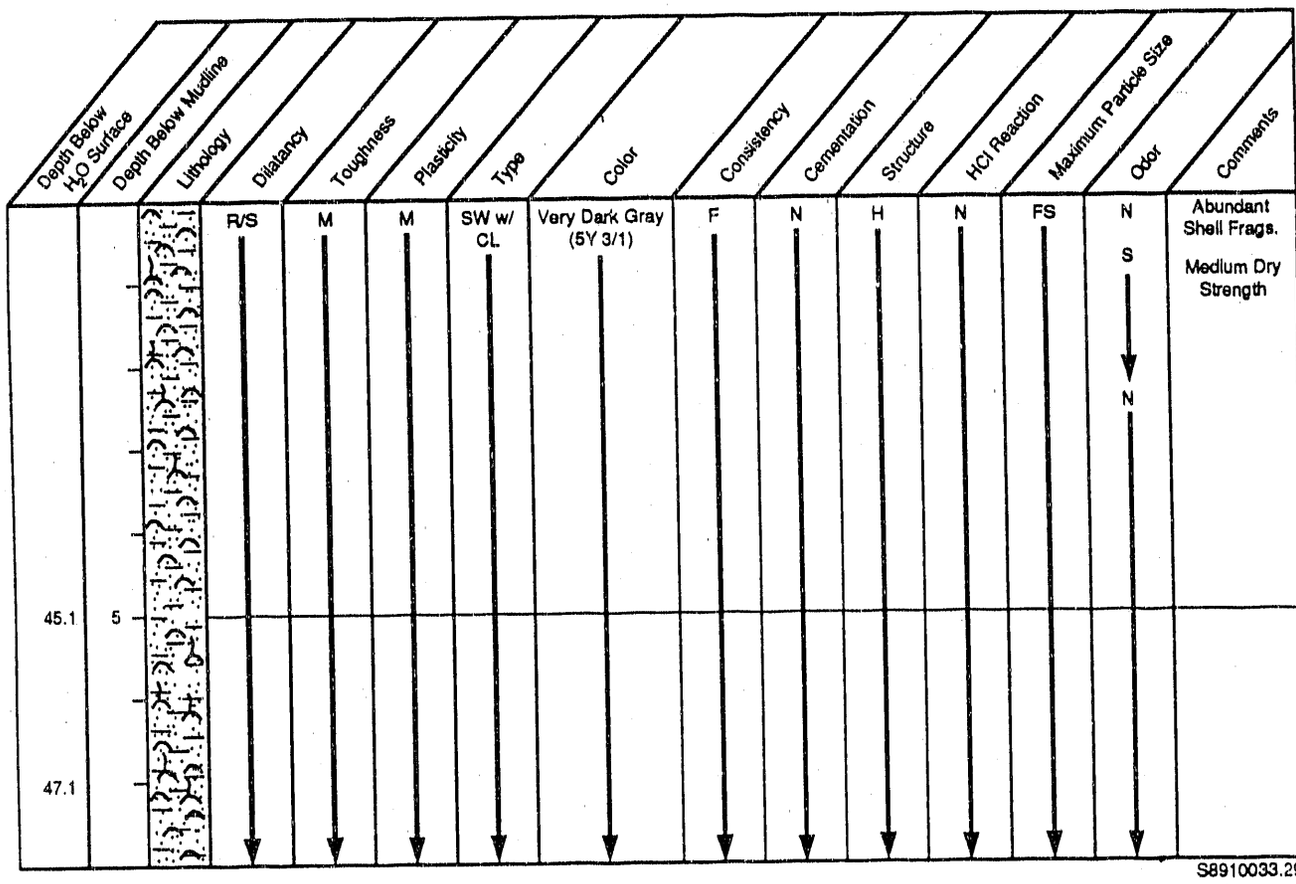
Core#: WR III C
Date: 9-19-89
Page 1 of 1

Mudline = 40.6' MLLW
Core Length = 0 - 5'
5' - 7.5'



Core#: WR II L
Date: 9-19-89
Page 1 of 1

Mudline = 40.1' MLLW
Core Length = 0 - 5'
5' - 8'



Core#: WR IR
Date: 9-19-89
Page 1 of 1

Mudline = 40.4' MLLW
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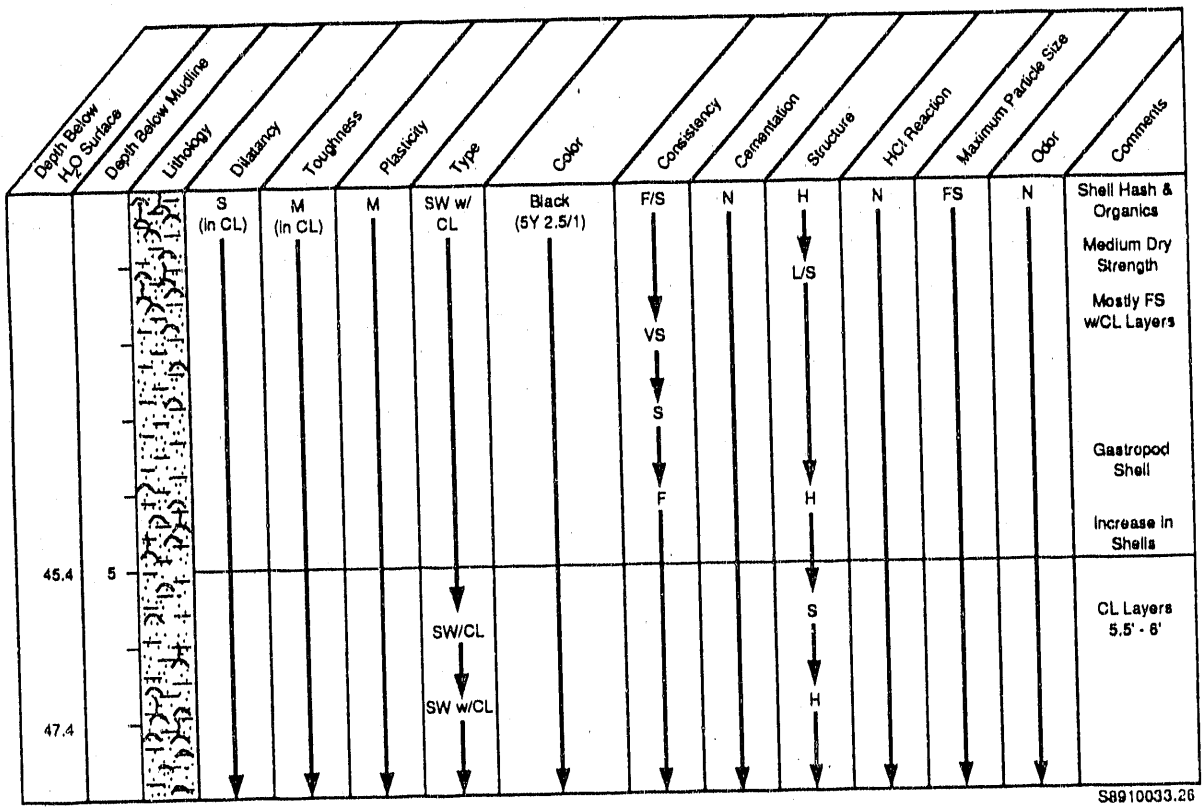
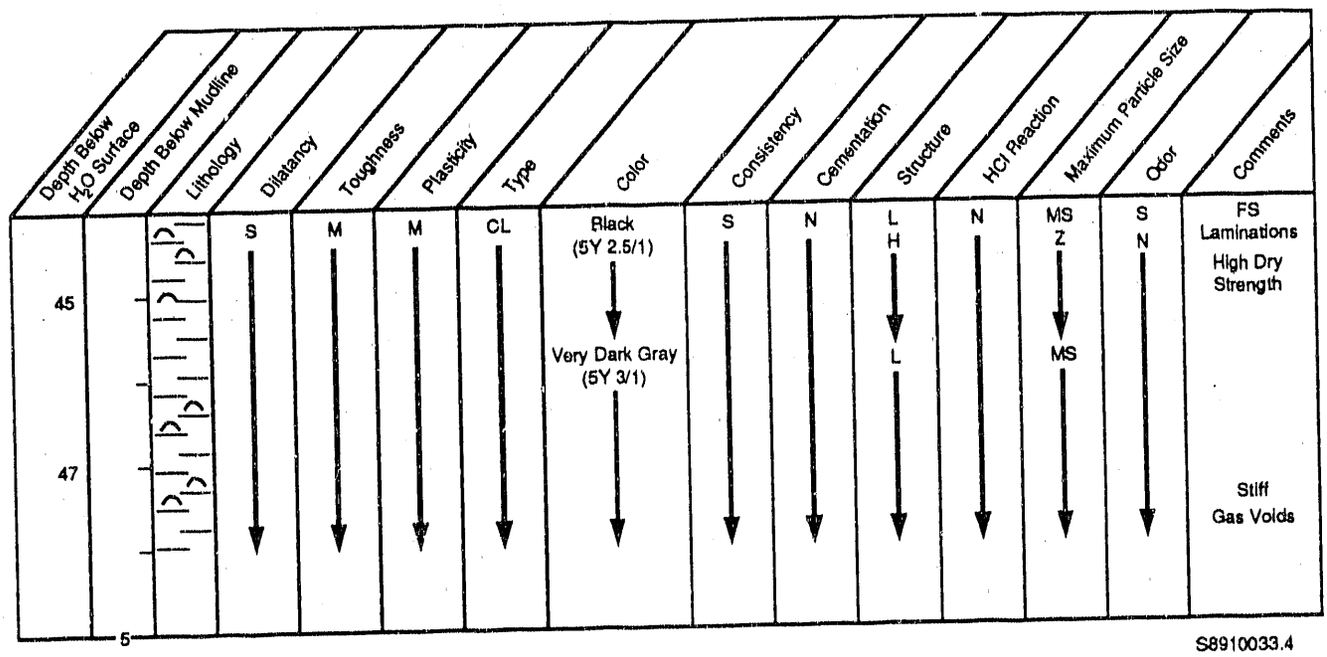
5' - 8'



Core#: P I C
Date: 9-19-89
Page 1 of 1

Mudline = 44' MLLW
Core Length = 0' - 4'



Core#: P II C
Date: 9-19-89
Page 1 of 1

Mudline = 42.7' MLLW
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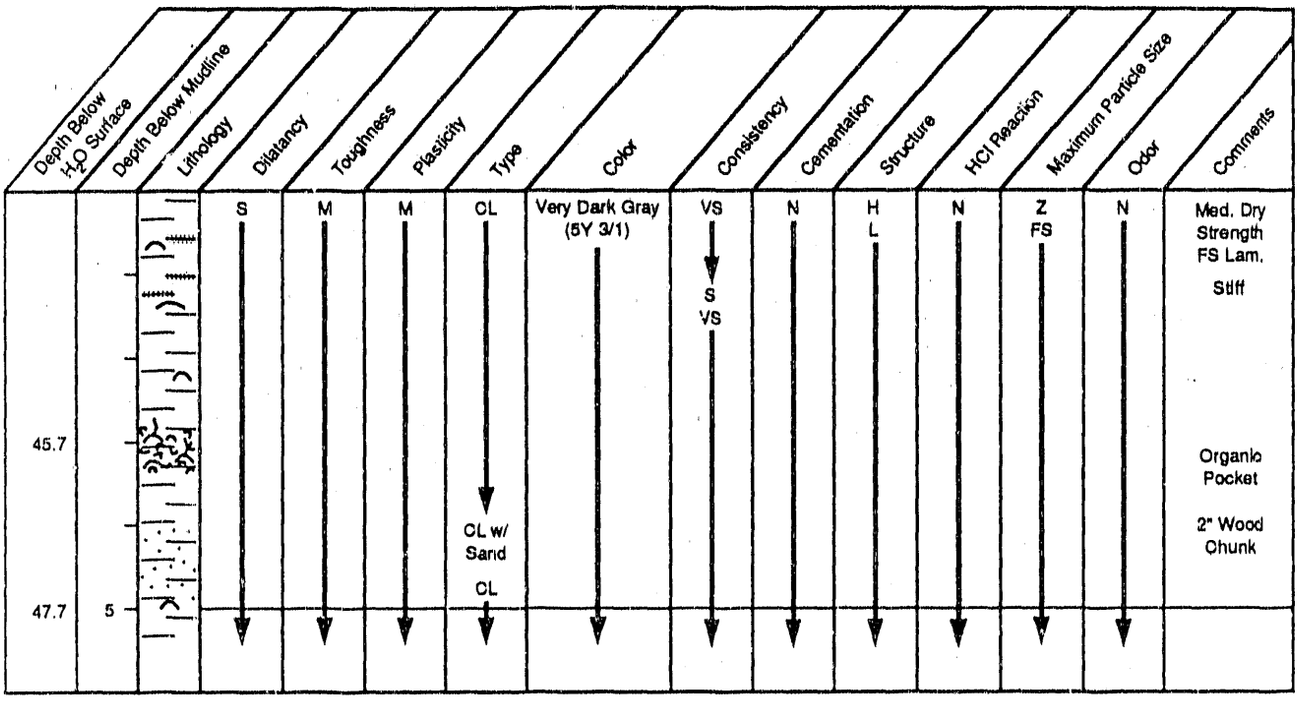
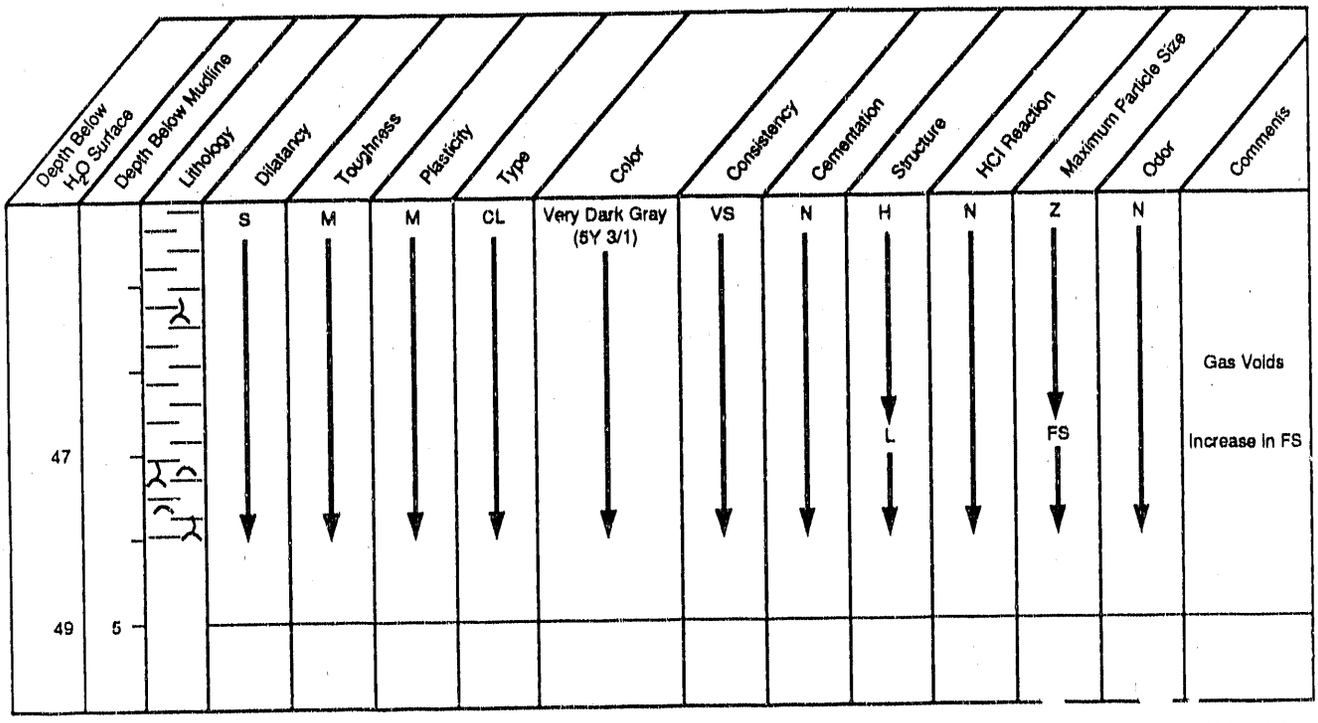


S8910033.9

Core#: P III L
Date: 9-19-89
Page 1 of 1

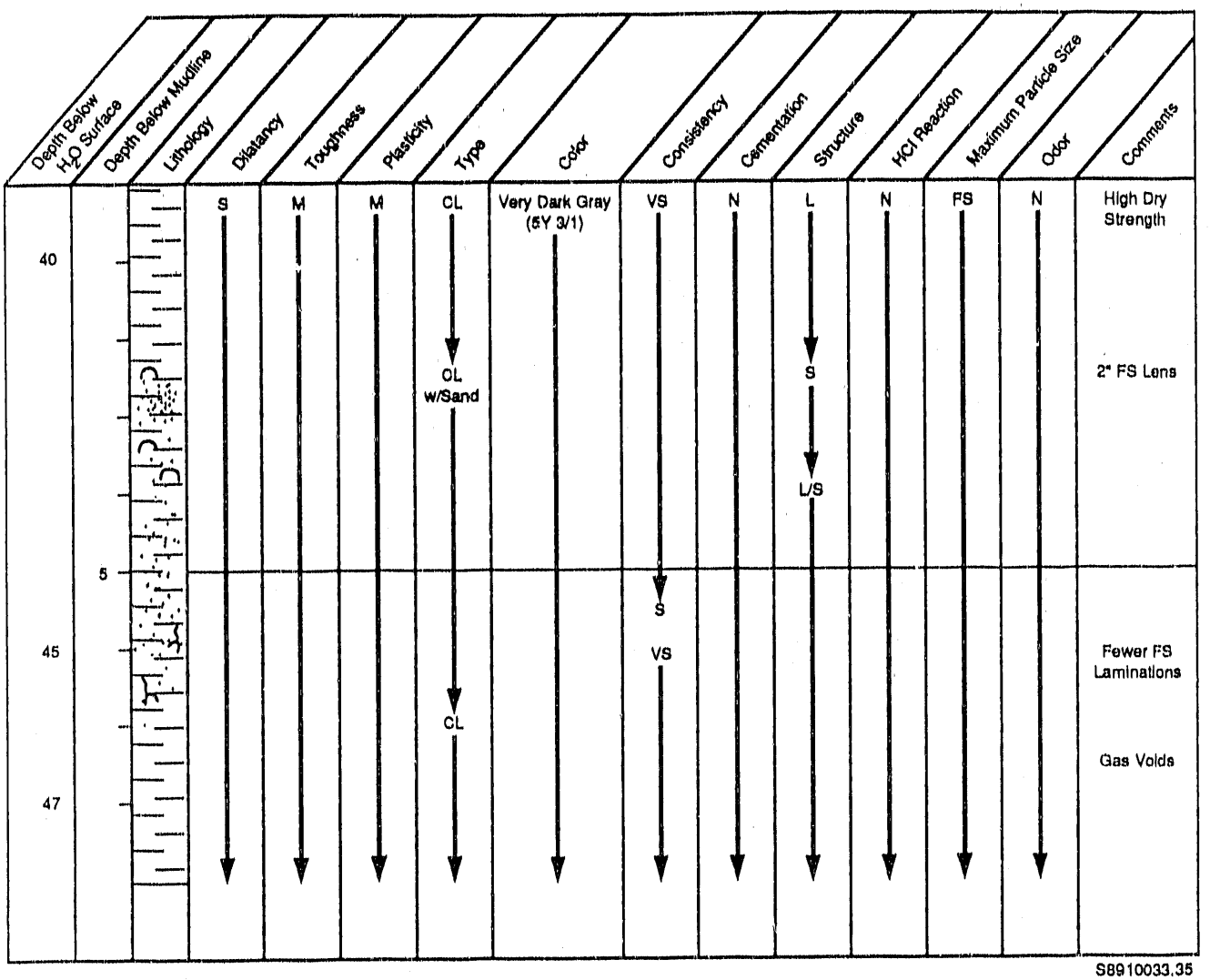
Mudline = 44' MLLW
Core Length = 0' - 4'



S8910033.5

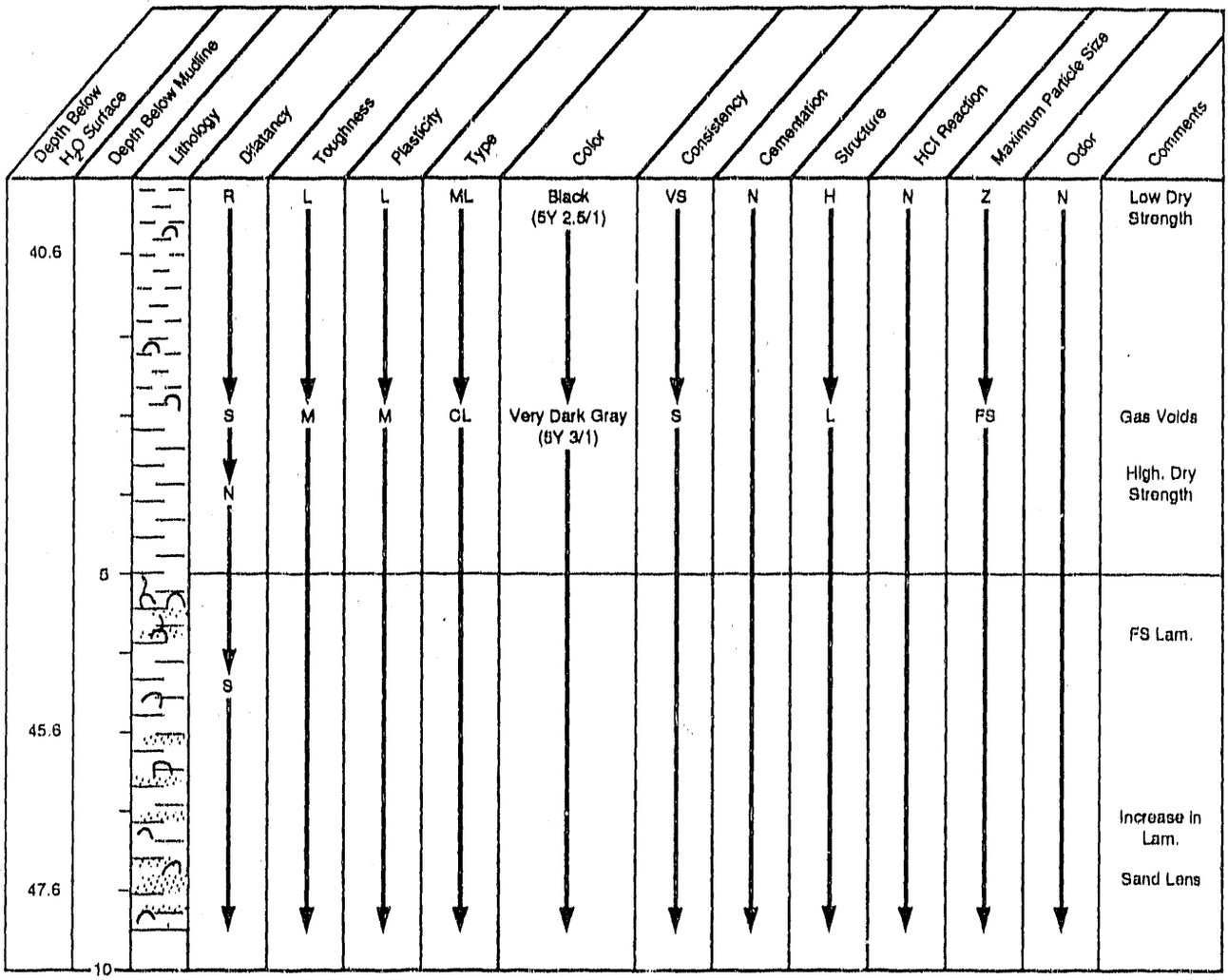
Core#: P IV R
Date: 9-19-89
Page 1 of 1

Mudline = 39' MLLW
Core Length = 0' - 5'
5' - 9



Core#: P V L
Date: 9-18-89
Page 1 of 1

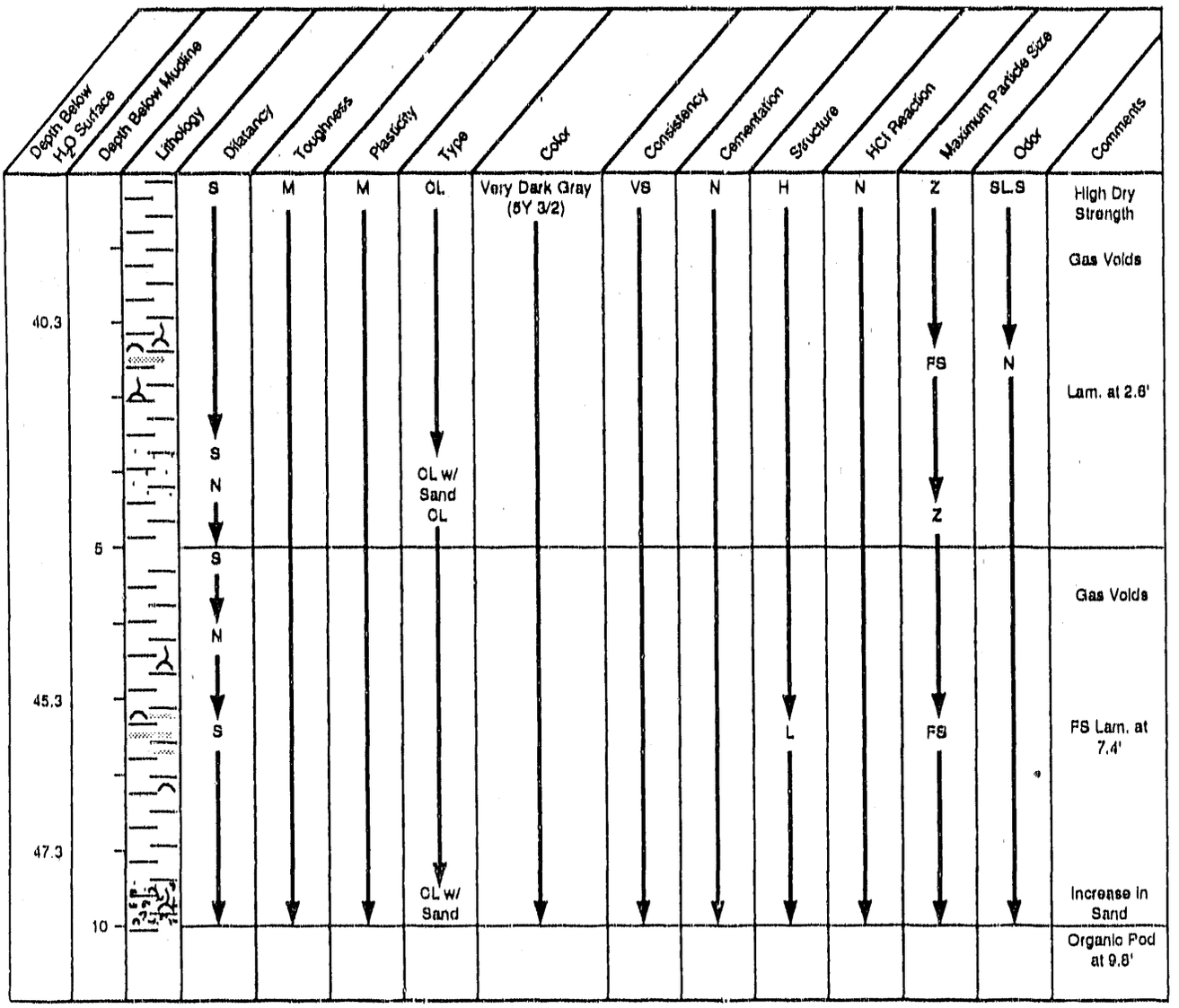
Mudline = 38.6' MLLW
Core Length = 0' - 5'
5' - 9.5'



S8910033.33

Core#: P V C
Date: 9-19-89
Page 1 of 1

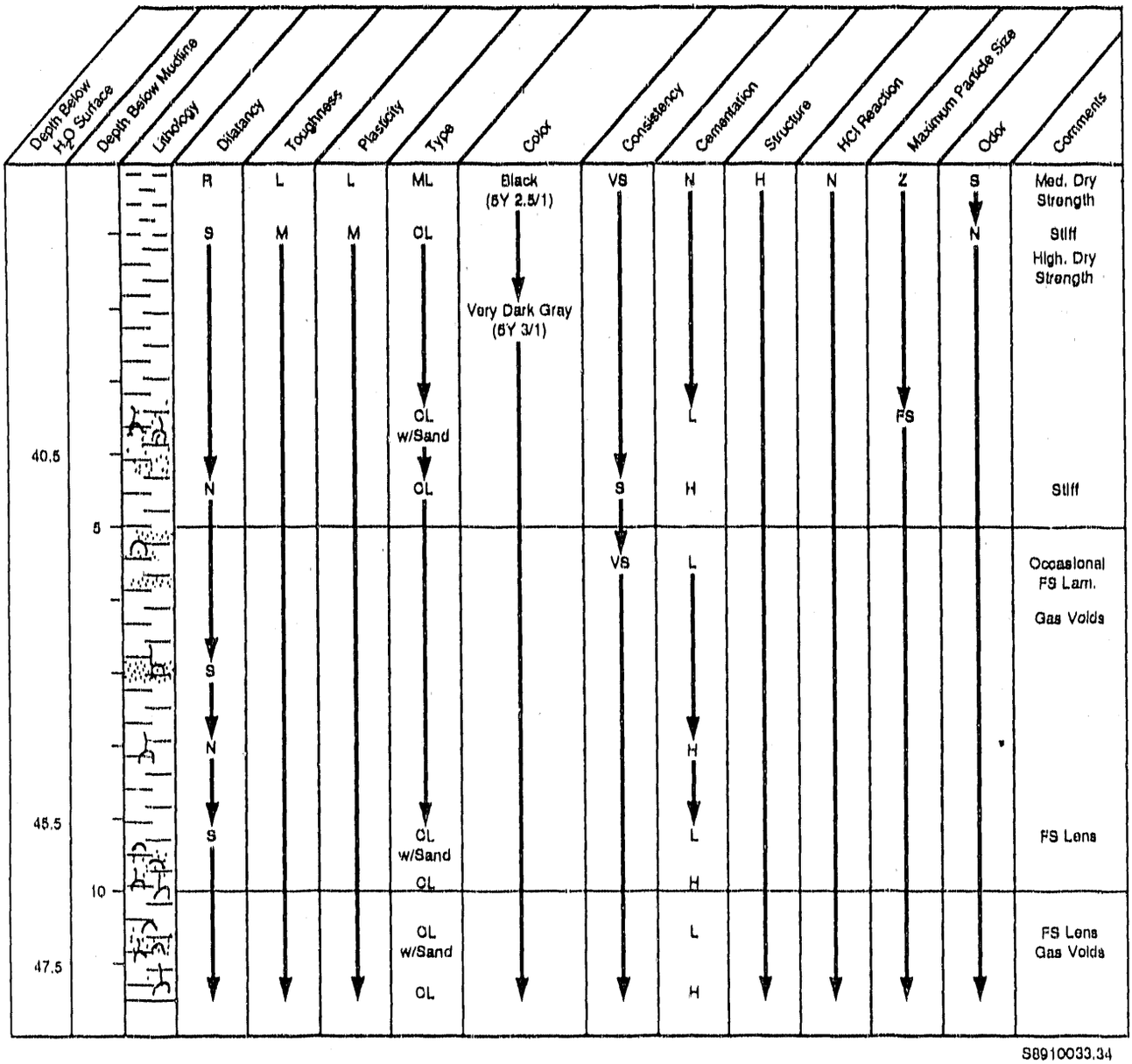
Mudline = 38.3' MLLW
Core Length = 0' - 5'
5' - 10'



S8910033.10

Core#: P V R
Date: 9-19-89
Page 1 of 1

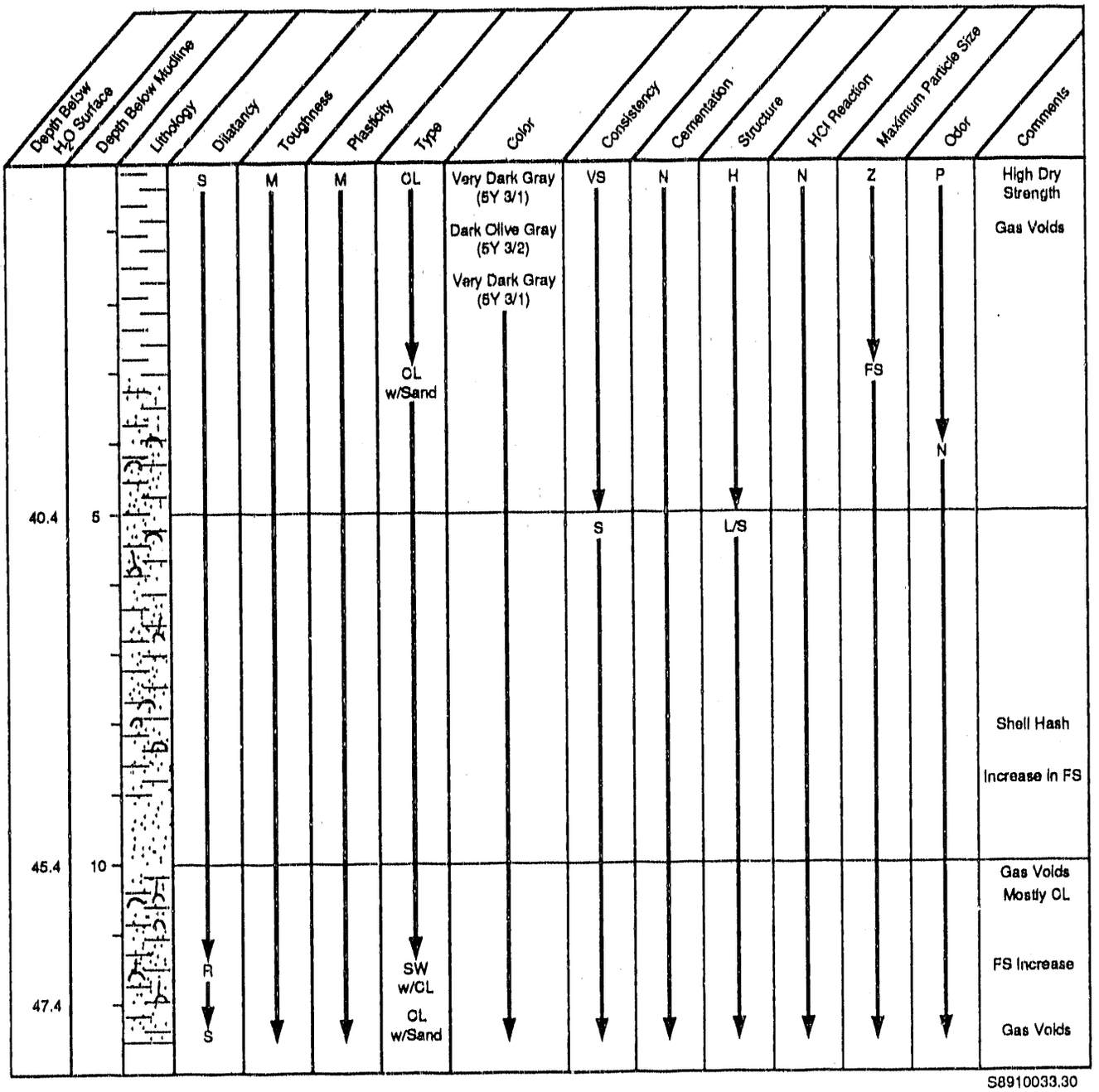
Mudline = 36.5' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 11.5'



S8910033.34

Core#: P VI L
Date: 9-18-89
Page 1 of 1

Mudline = 35.4' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 12.6'



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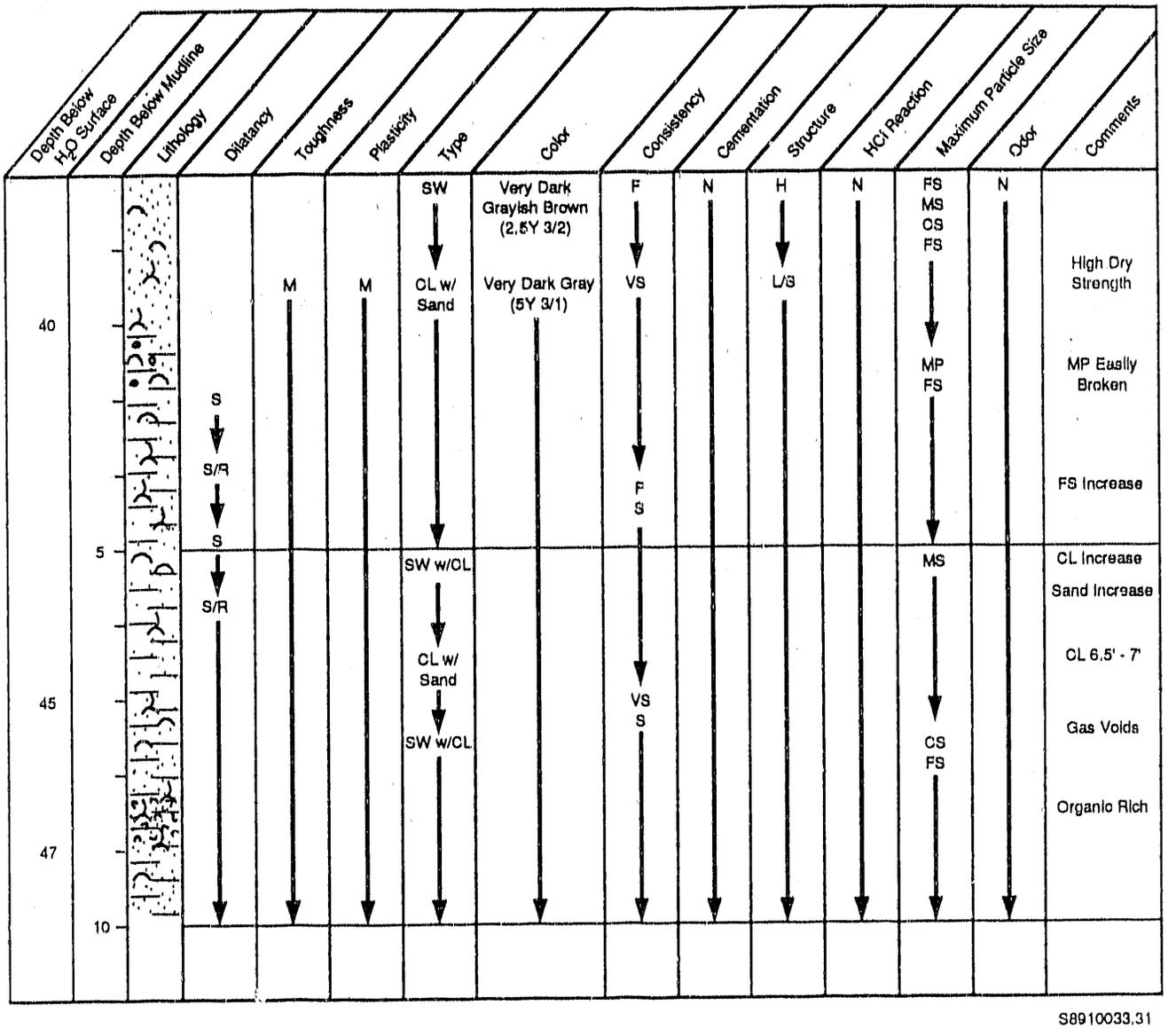
Date: 9-18-89
Page 1 of 1

Mudline = 38.0' MLLW
Core Length = 0' - 5'
5' - 10'



S8910033.31

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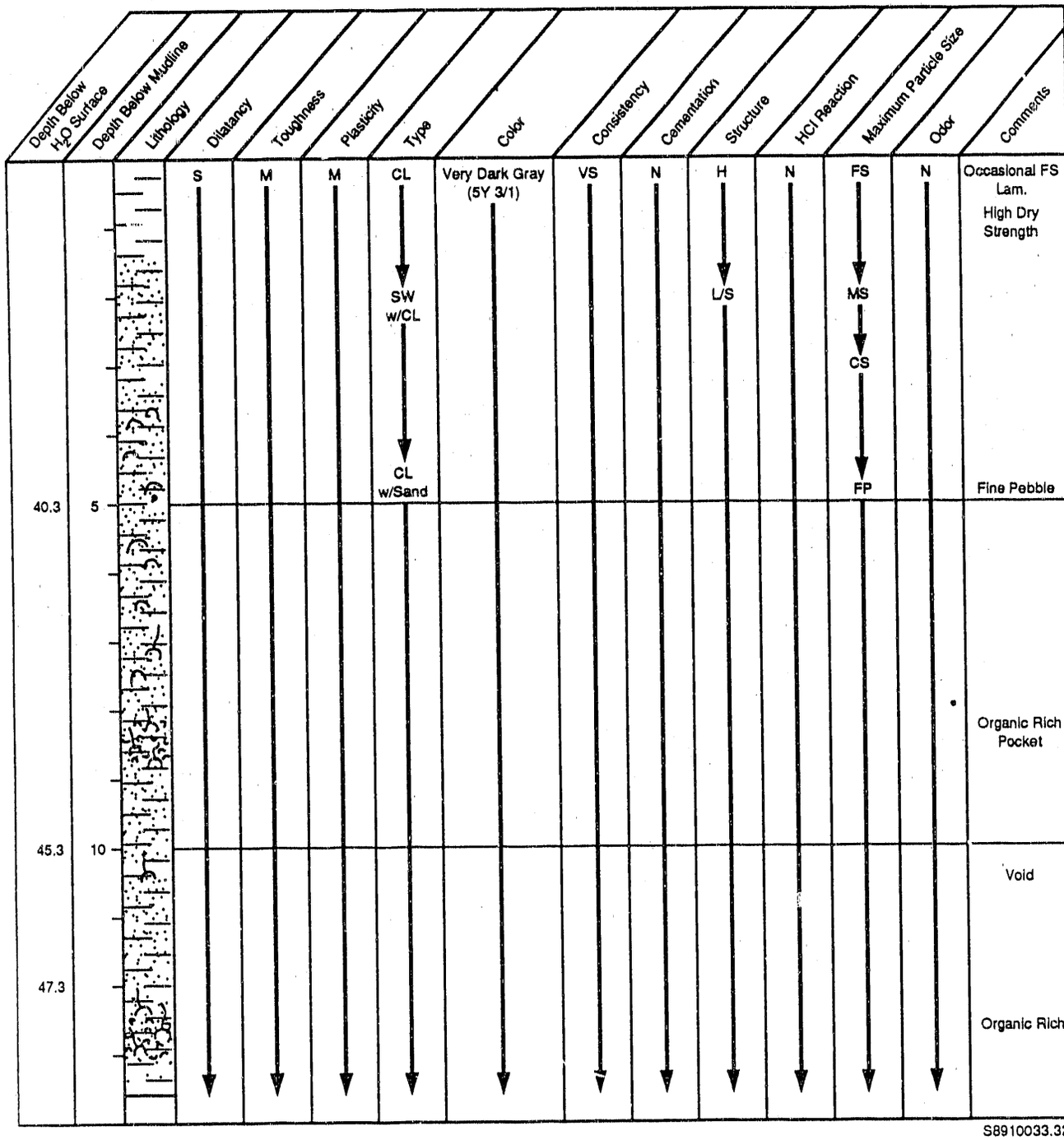
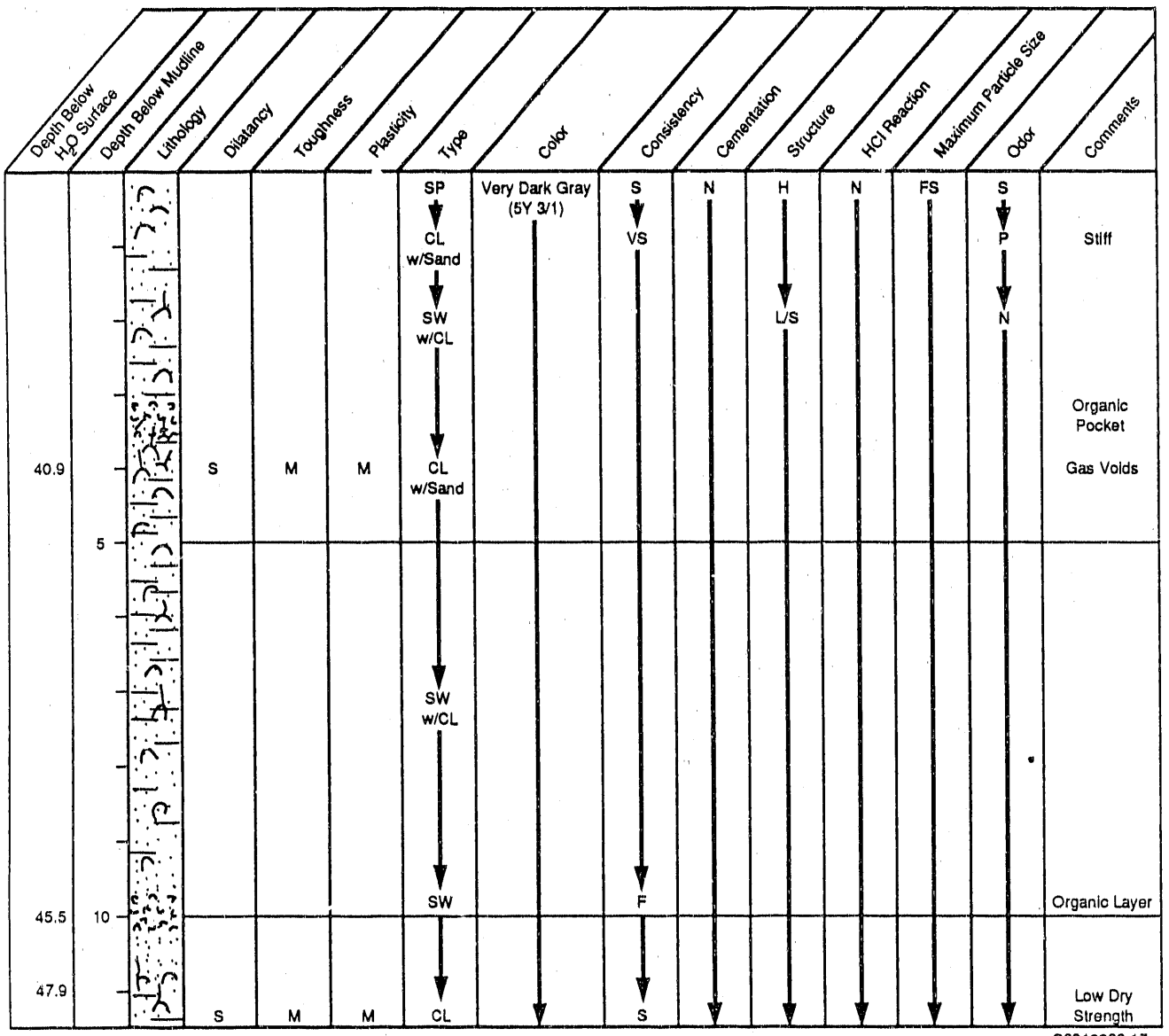
Date: 9-18-89
Page 1 of 1

Mudline = 35.3' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 13.5'



Core#: P VII C
Date: 9-18-89
Page 1 of 1

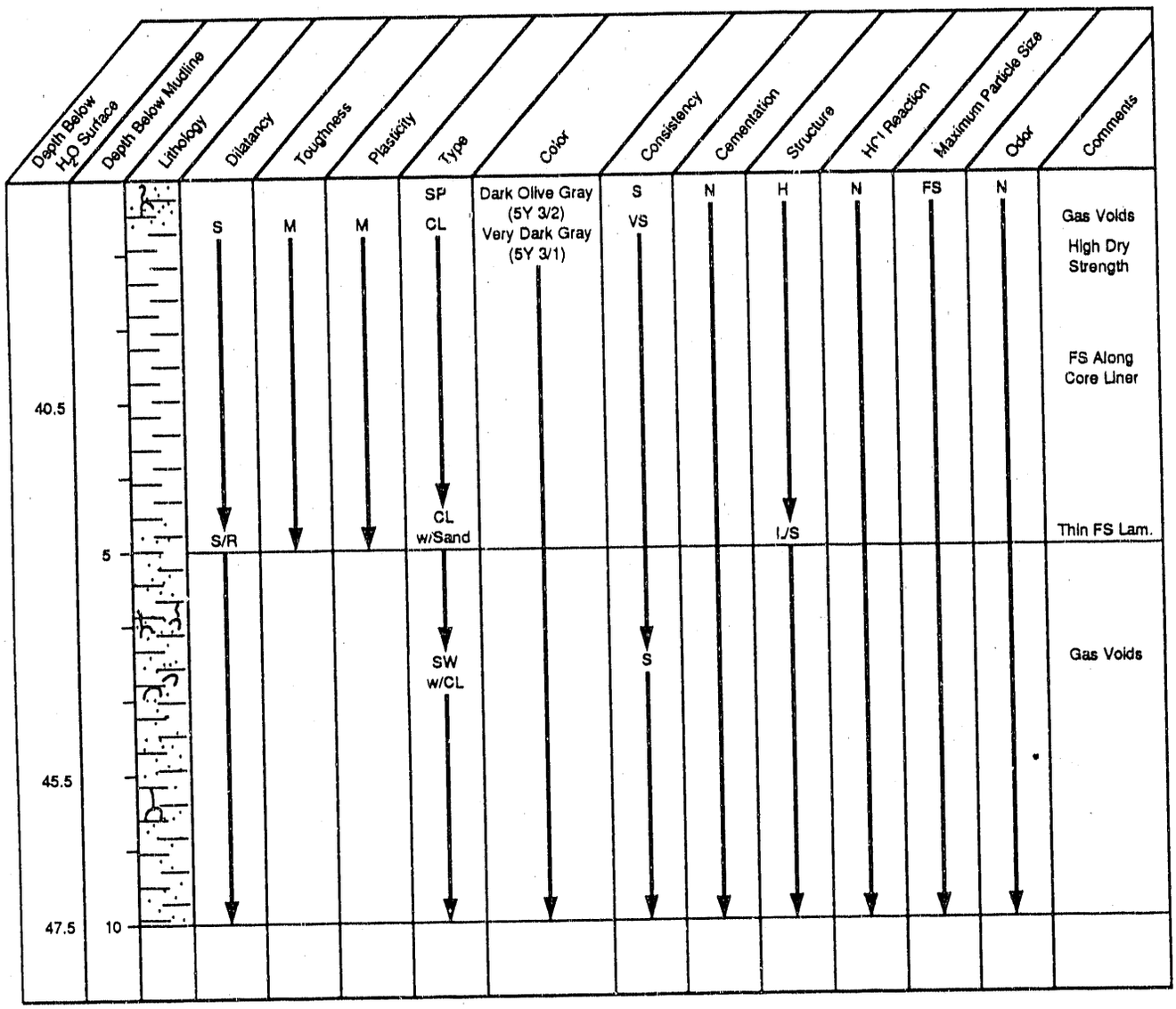
Mudline = 36.9' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 11.5'



S8910033.17

Core#: PVIII L
Date: 9-18-89
Page 1 of 1

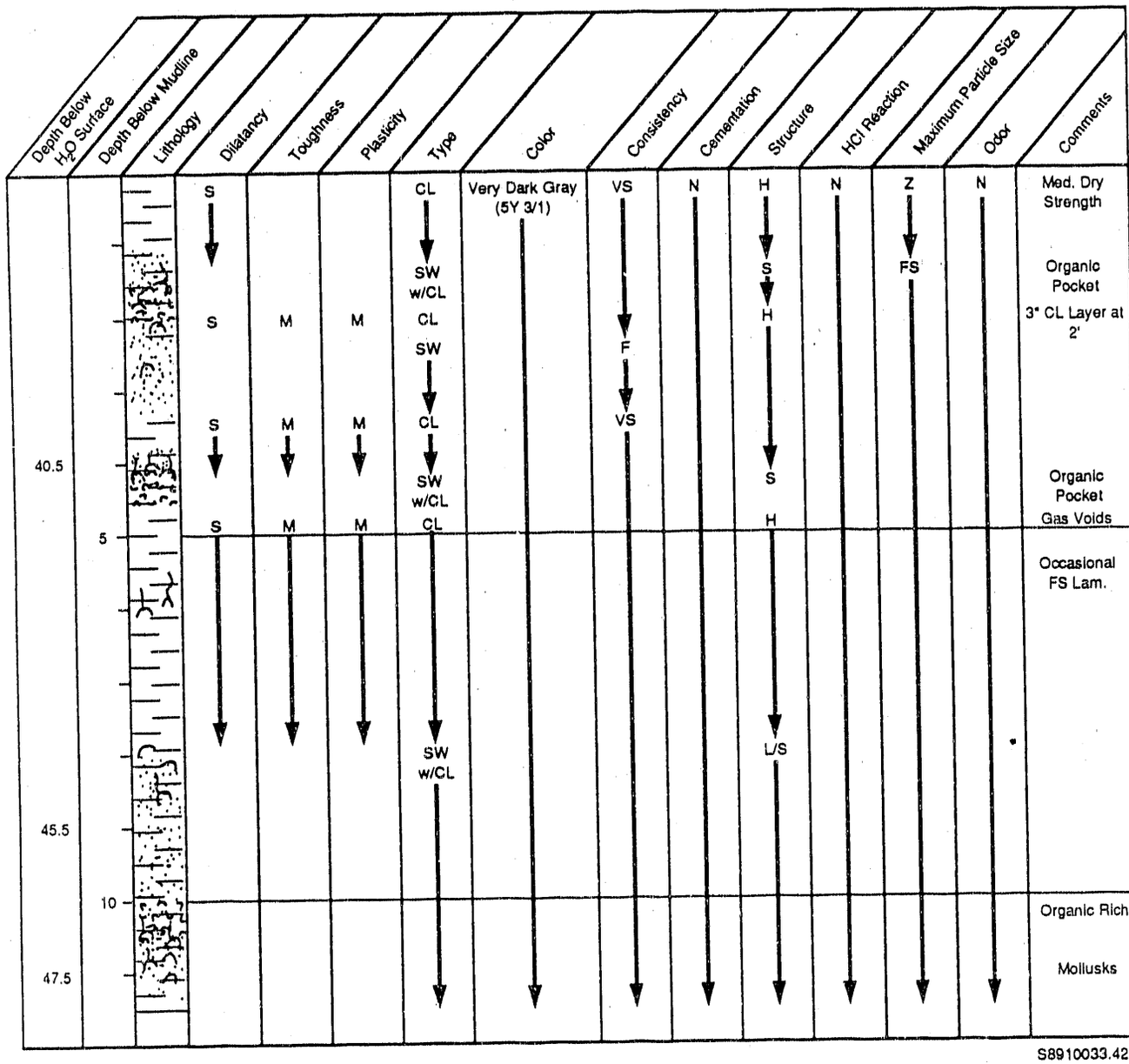
Mudline = 37.5' MLLW
Core Length = 0' - 5'
5' - 10'



S8910033.41

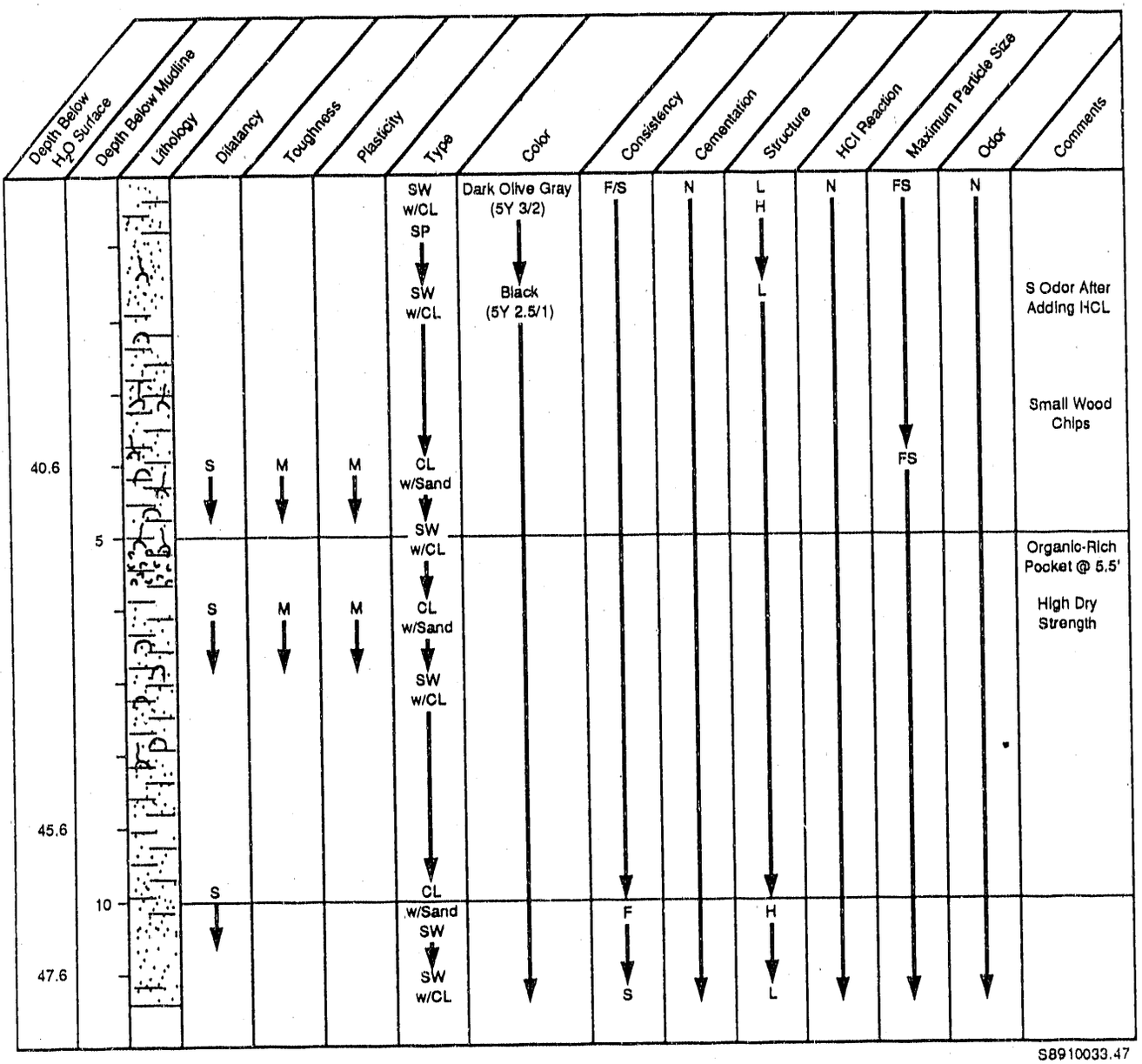
Core#: P VIII R
Date: 9-18-89
Page 1 of 1

Mudline = 36.5' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 11.5'



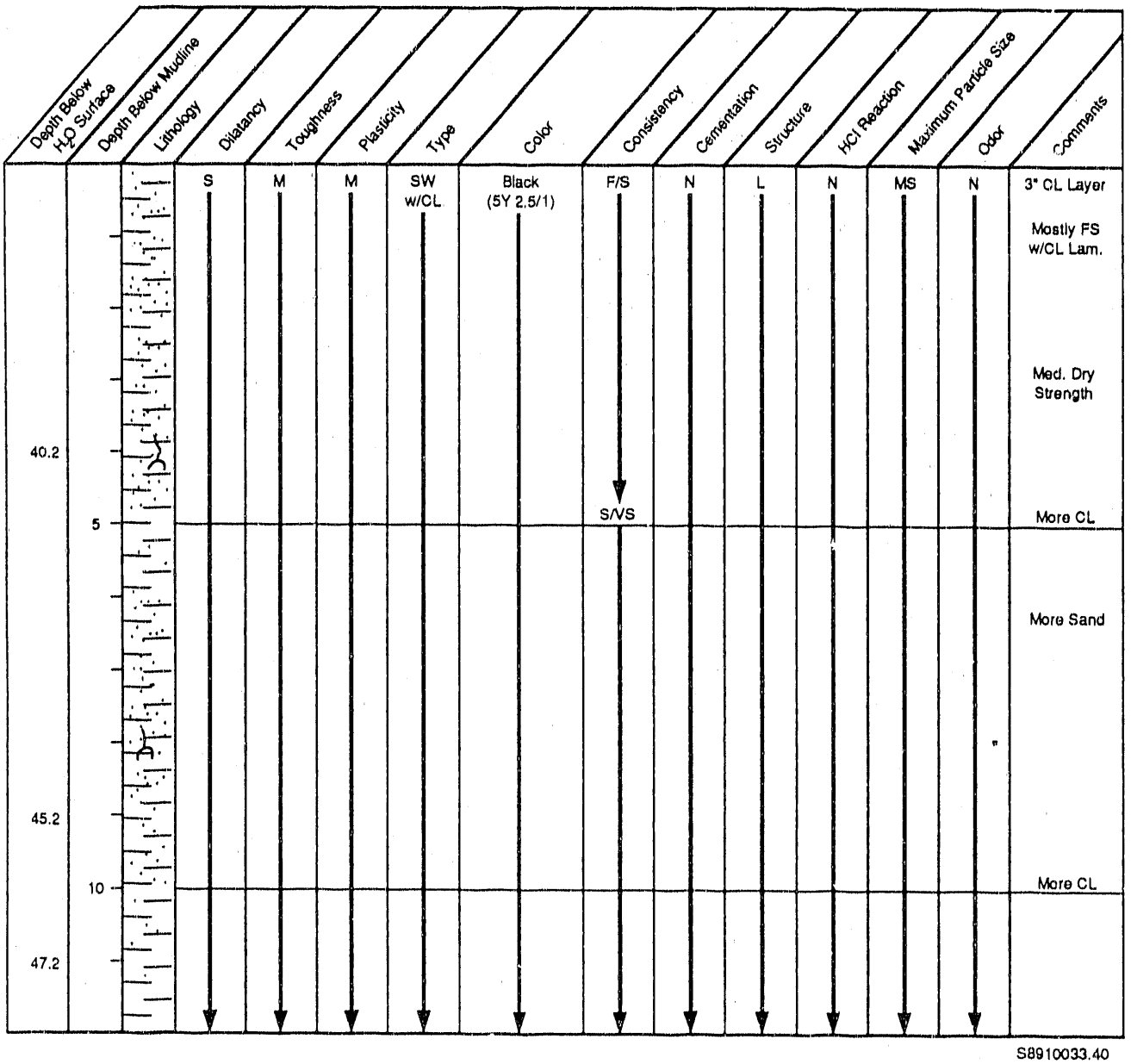
Core#: P VIII.5 C
Date: 9-18-89
Page 1 of 1

Mudline = 36.6' MLLW
Core Length = 0' - 5'
5' - 10'
10' -11.8'



Core#: PIX C
Date: 9-18-89
Page 1 of 1

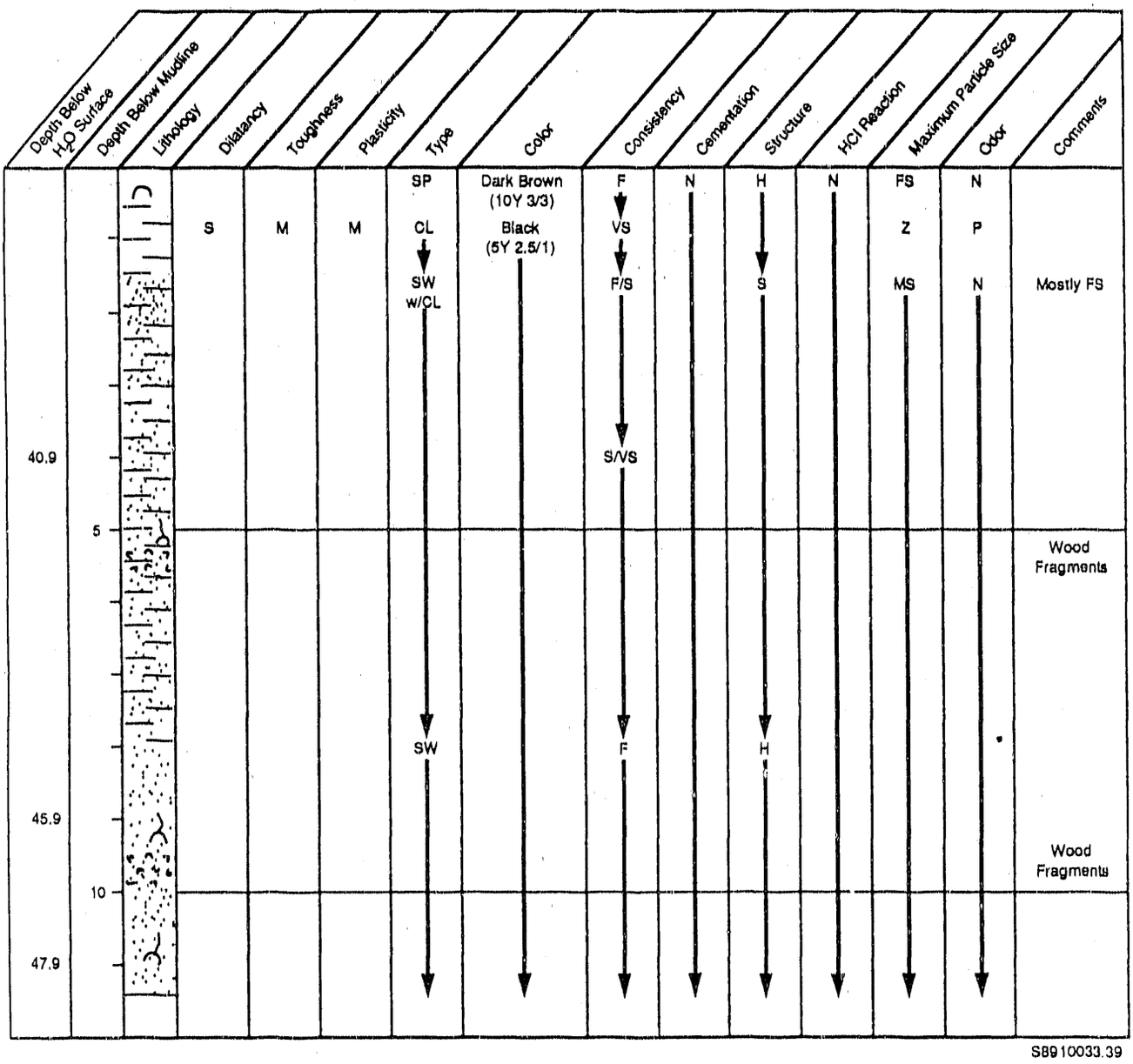
Mudline = 36.2' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 12'



S8910033.40

Core#: P IX.5 L
Date: 9-18-89
Page 1 of 1

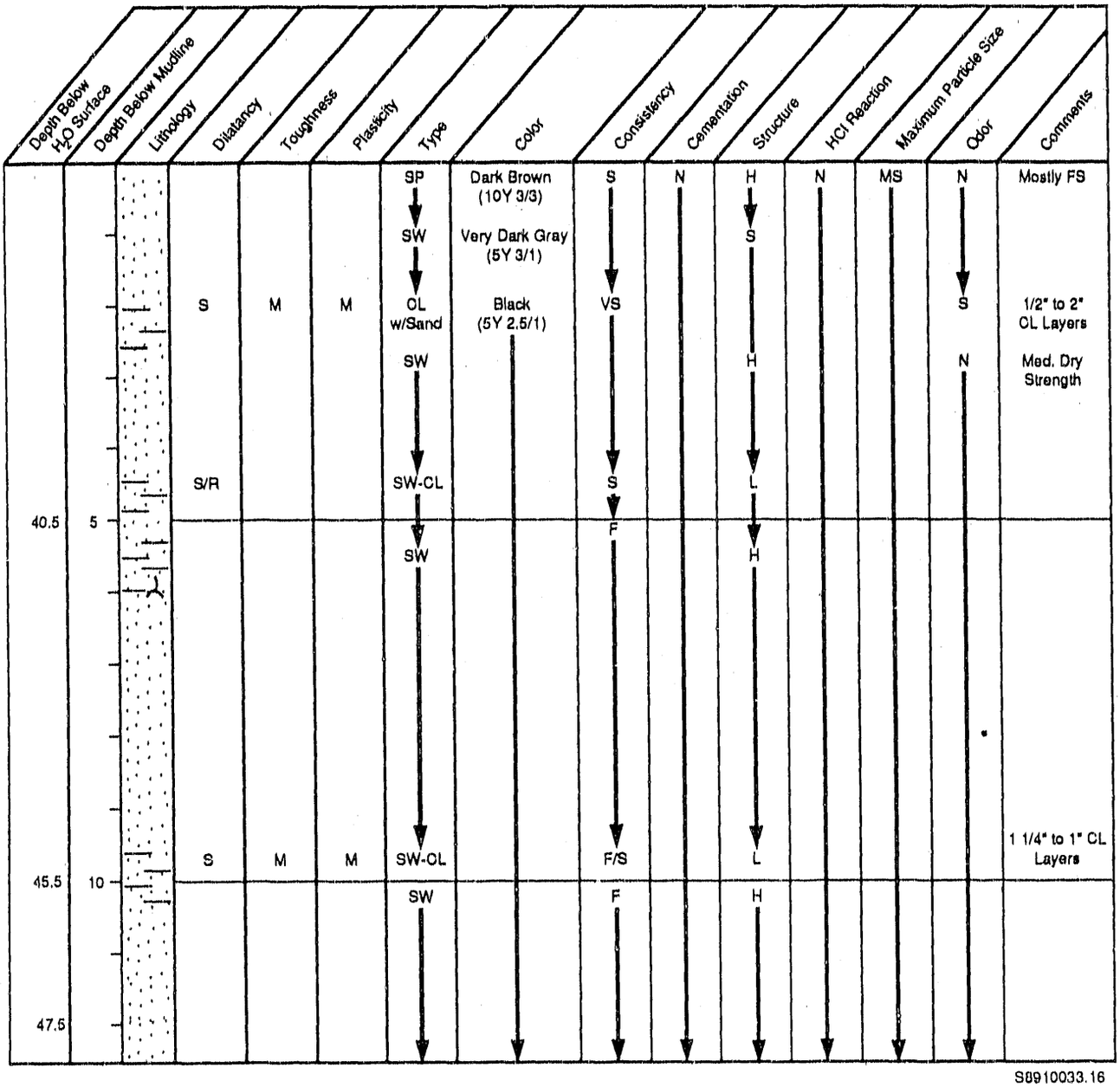
Mudline = 36.9' MLLW
Core Length = 0' - 4'
4' - 8'
8' -11.5'



SB910033.39

Core#: P X R
Date: 9-18-89
Page 1 of 1

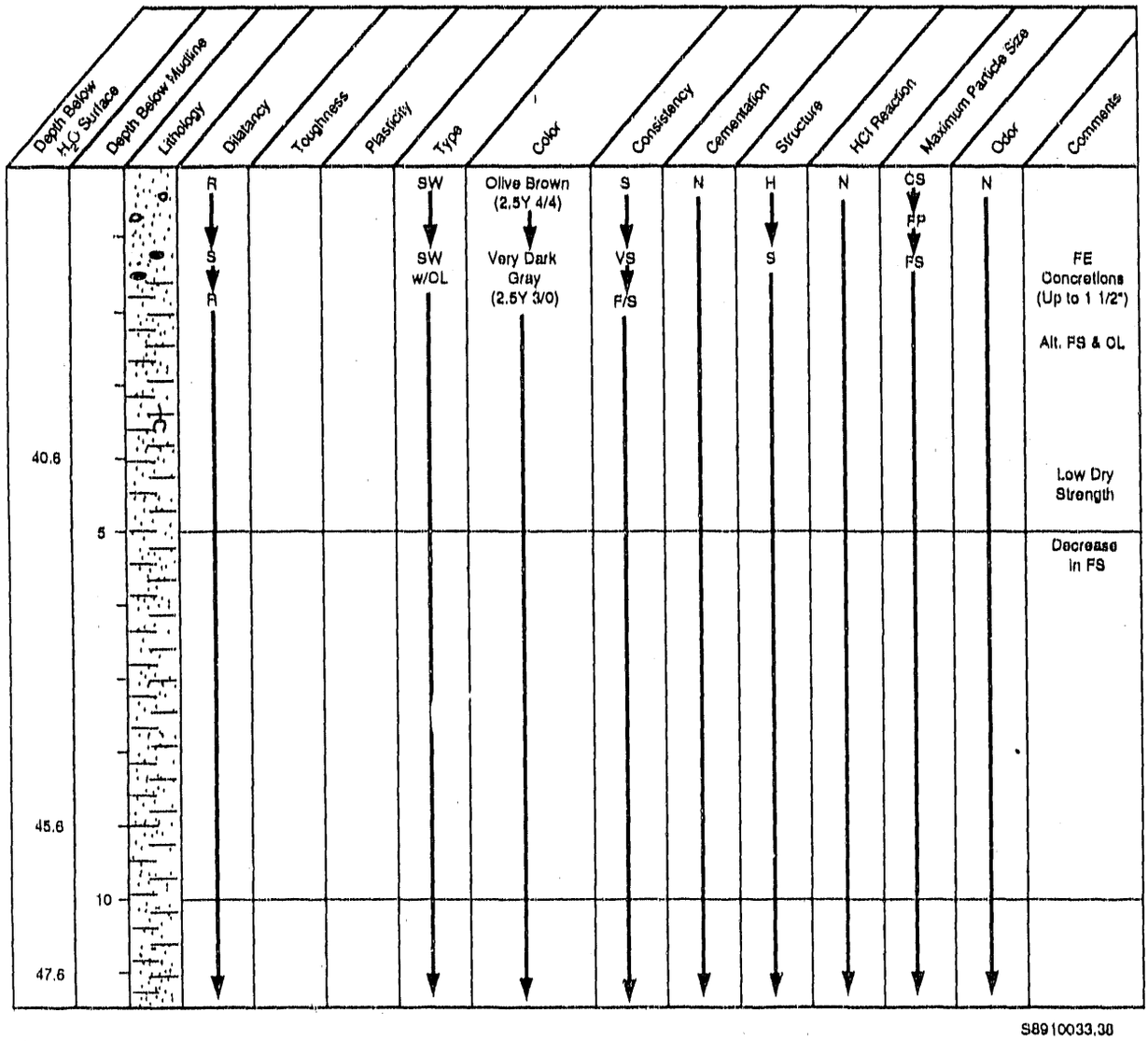
Mudline = 35.5' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 12.5'



S8910033.16

Core#: P X.5 C
Date: 9-15-89
Page 1 of 1

Mudline = 36.6' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 11.5'



S8910033.3B

Core#: PXIL
Date: 9-15-89
Page 1 of 1

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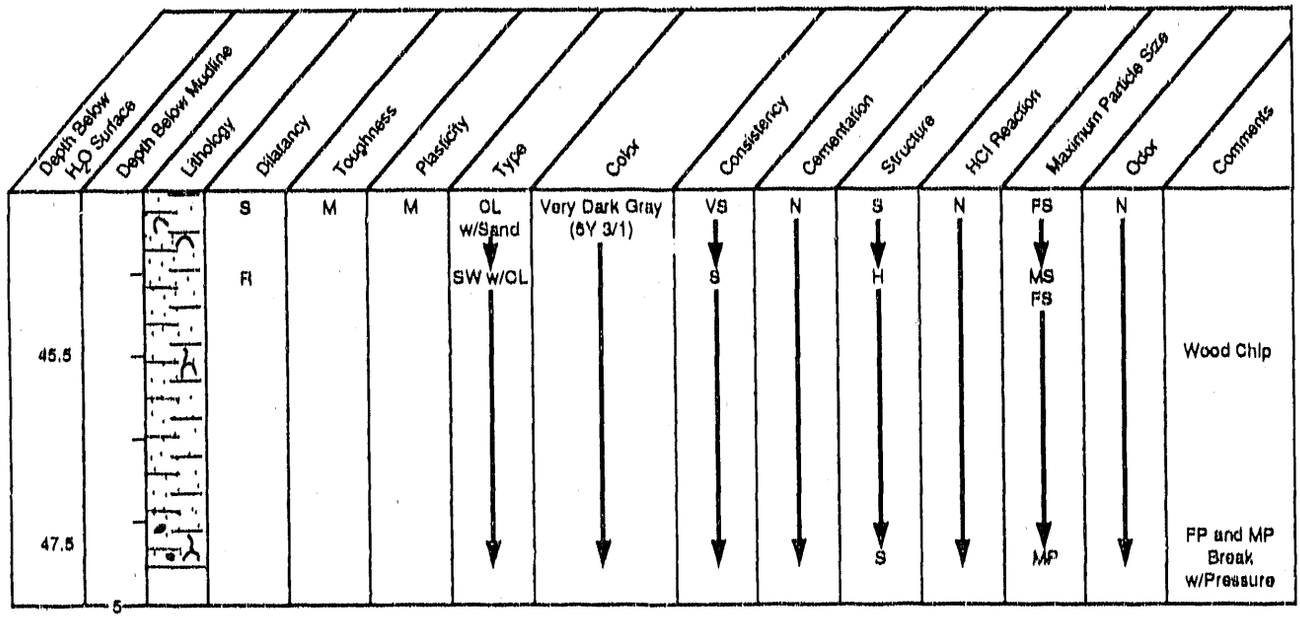
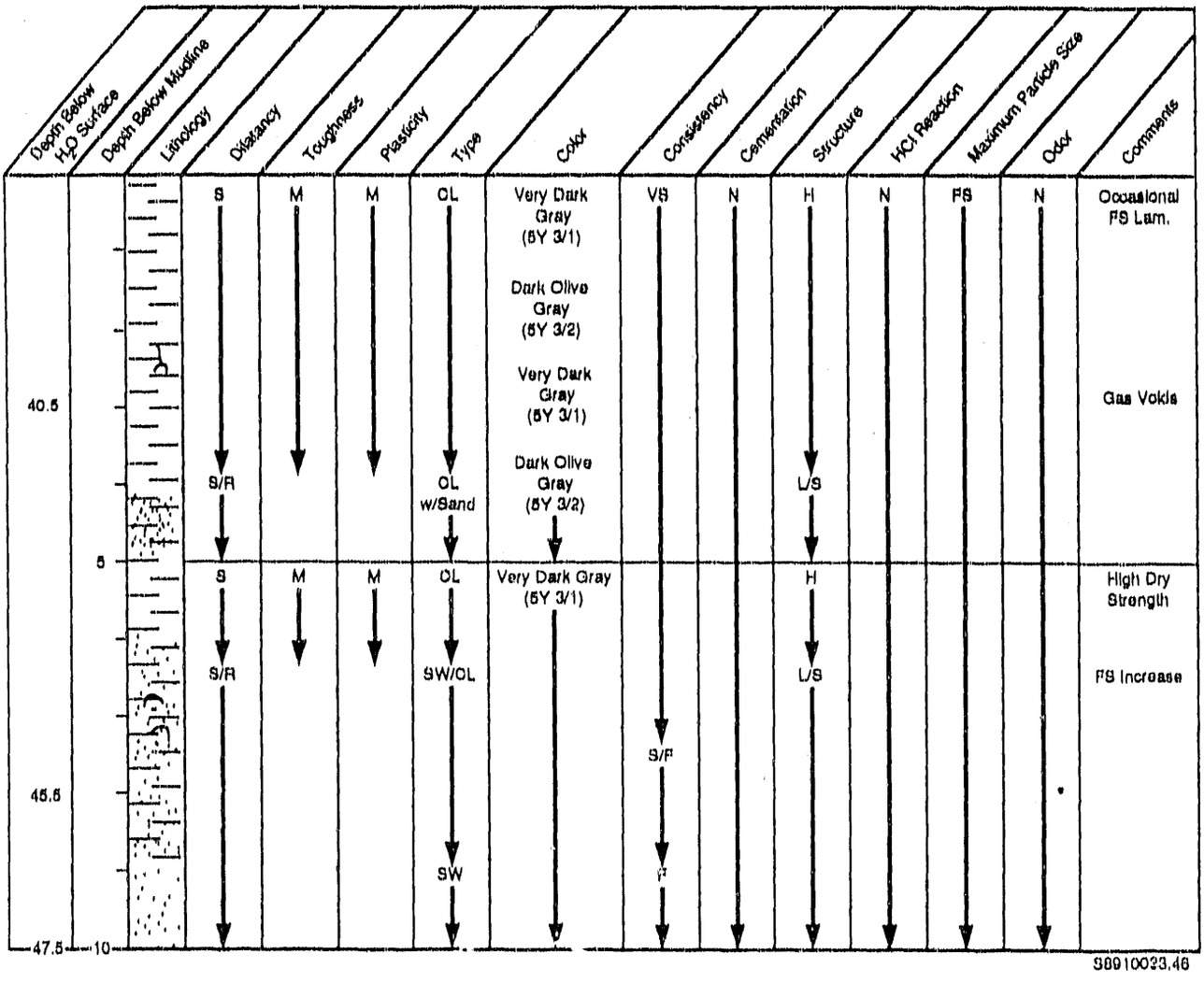
Core Length = 4.5'



S8910033.37

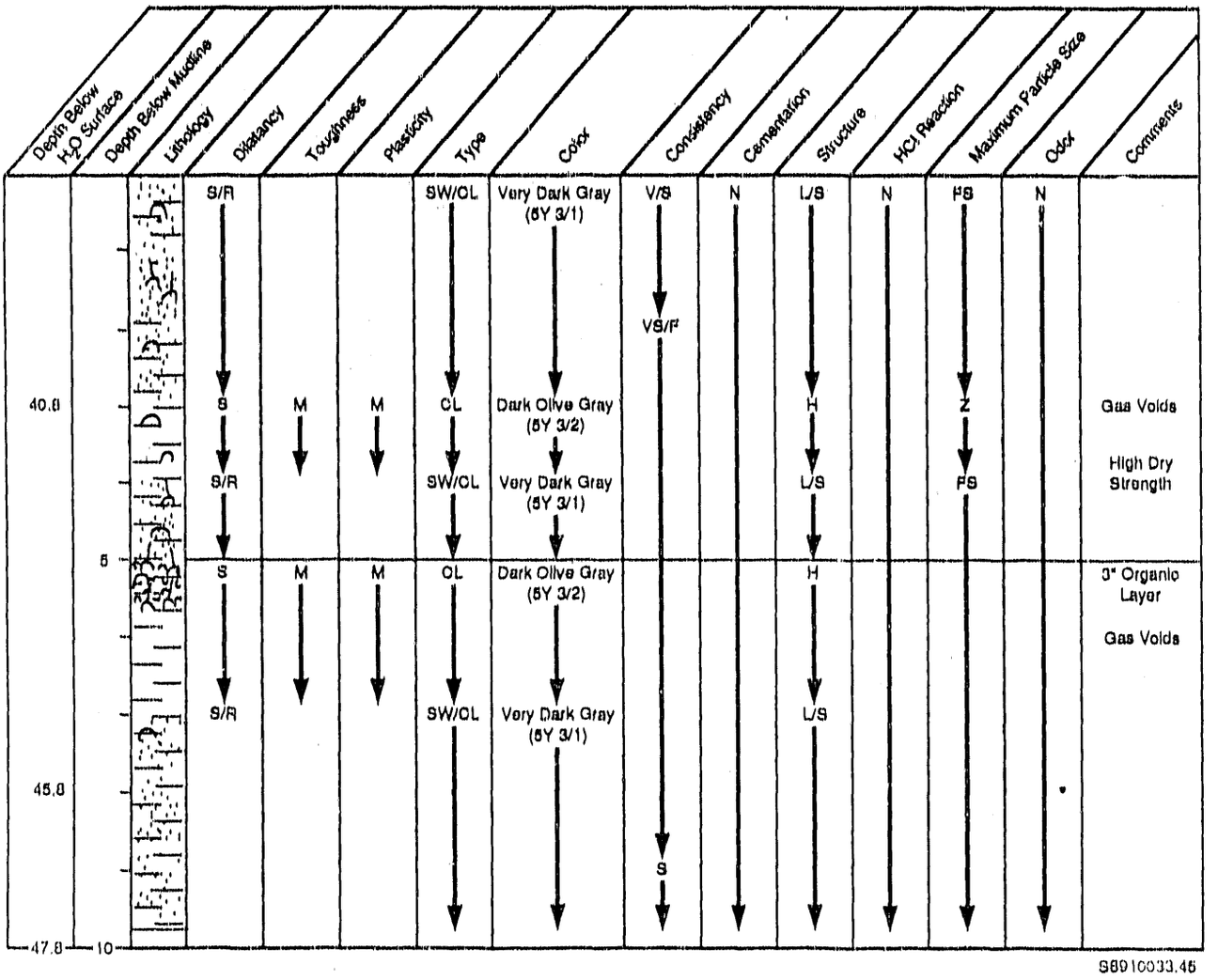
Core#: P XII R
Date: 9-15-89
Page 1 of 1

Mudline = 38.5' MLLW
Core Length = 0' - 5'
5' - 10'



Core#: P XII RR
Date: 9-15-89
Page 1 of 1

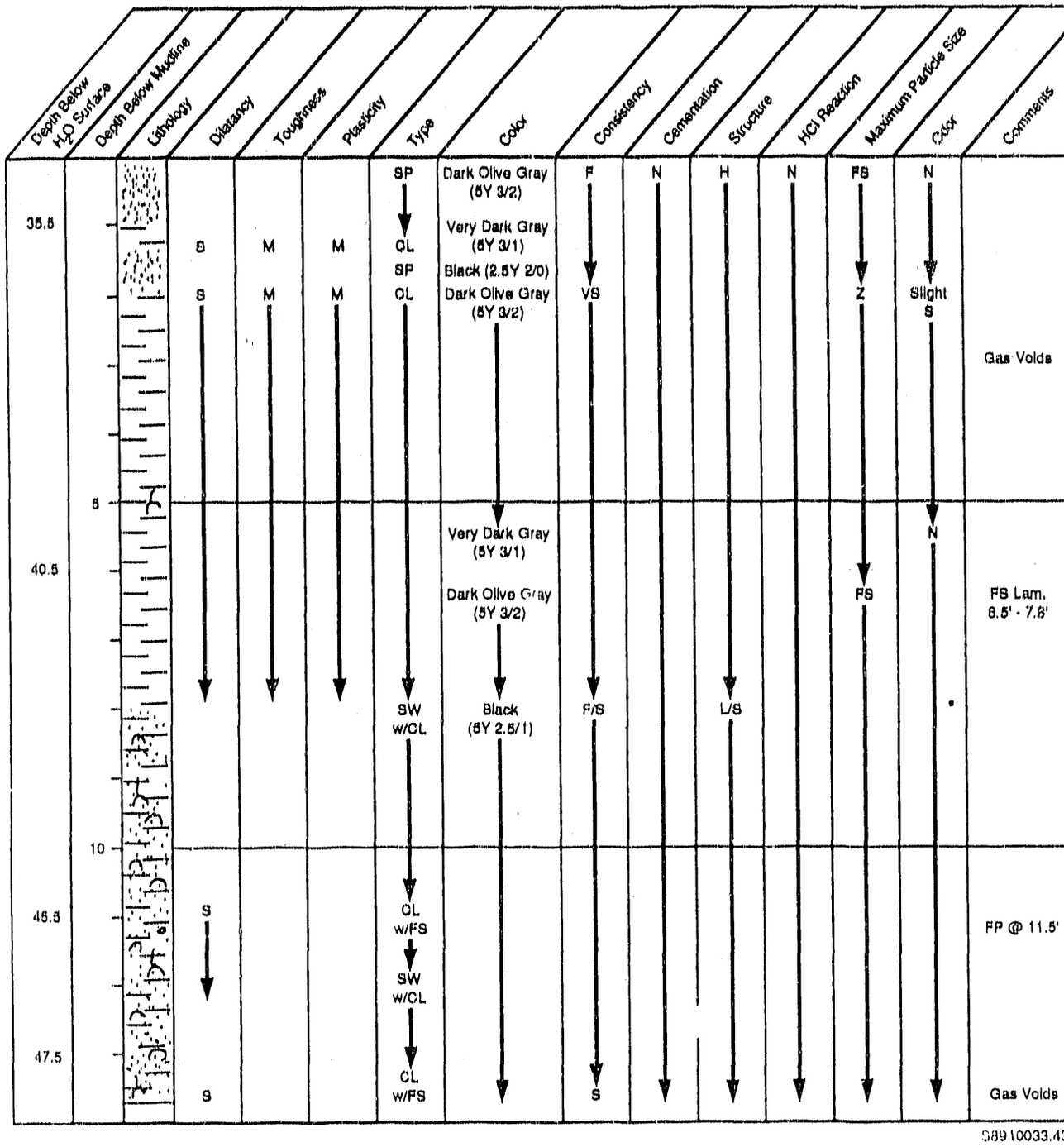
Mudline = 37.8' MLLW
Core Length = 0' - 5'
5' - 9.8'



S89100033.46

Core#: P XII B2
Date: 9-19-89
Page 1 of 1

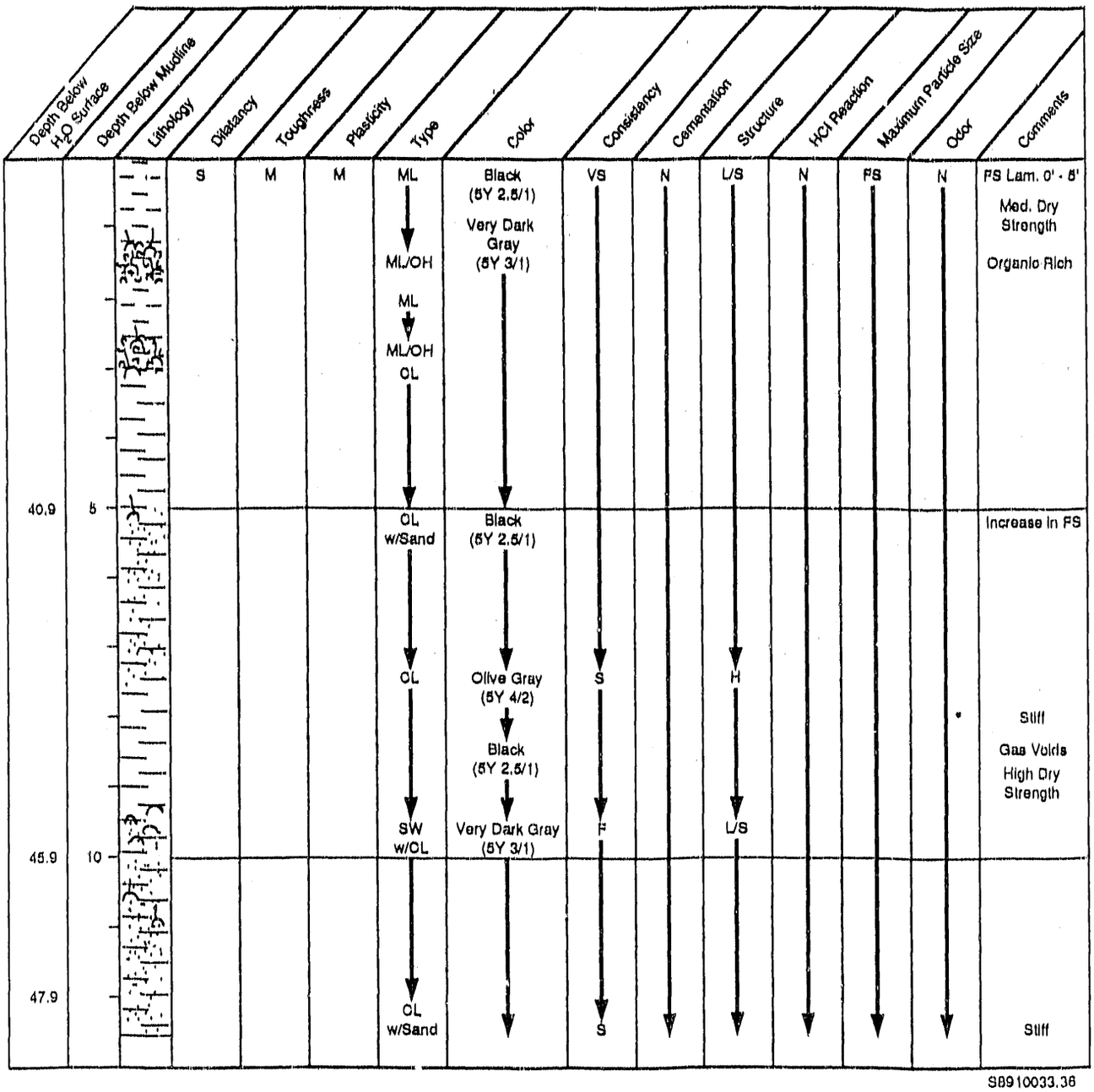
Mudline = 34.5' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 13.7'



S89100033.43

Core#: P XII B1
Date: 9-19-89
Page 1 of 1

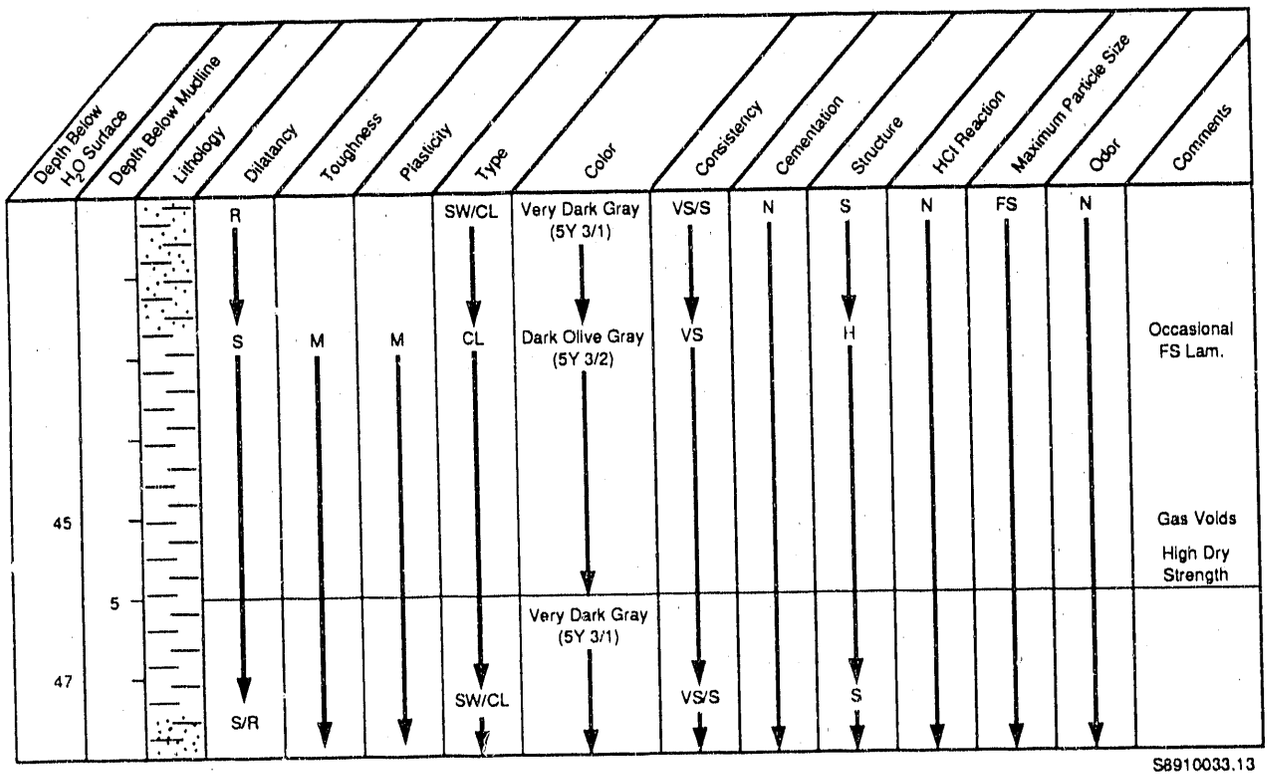
Mudline = 35.9' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 12.5'



S8910033.36

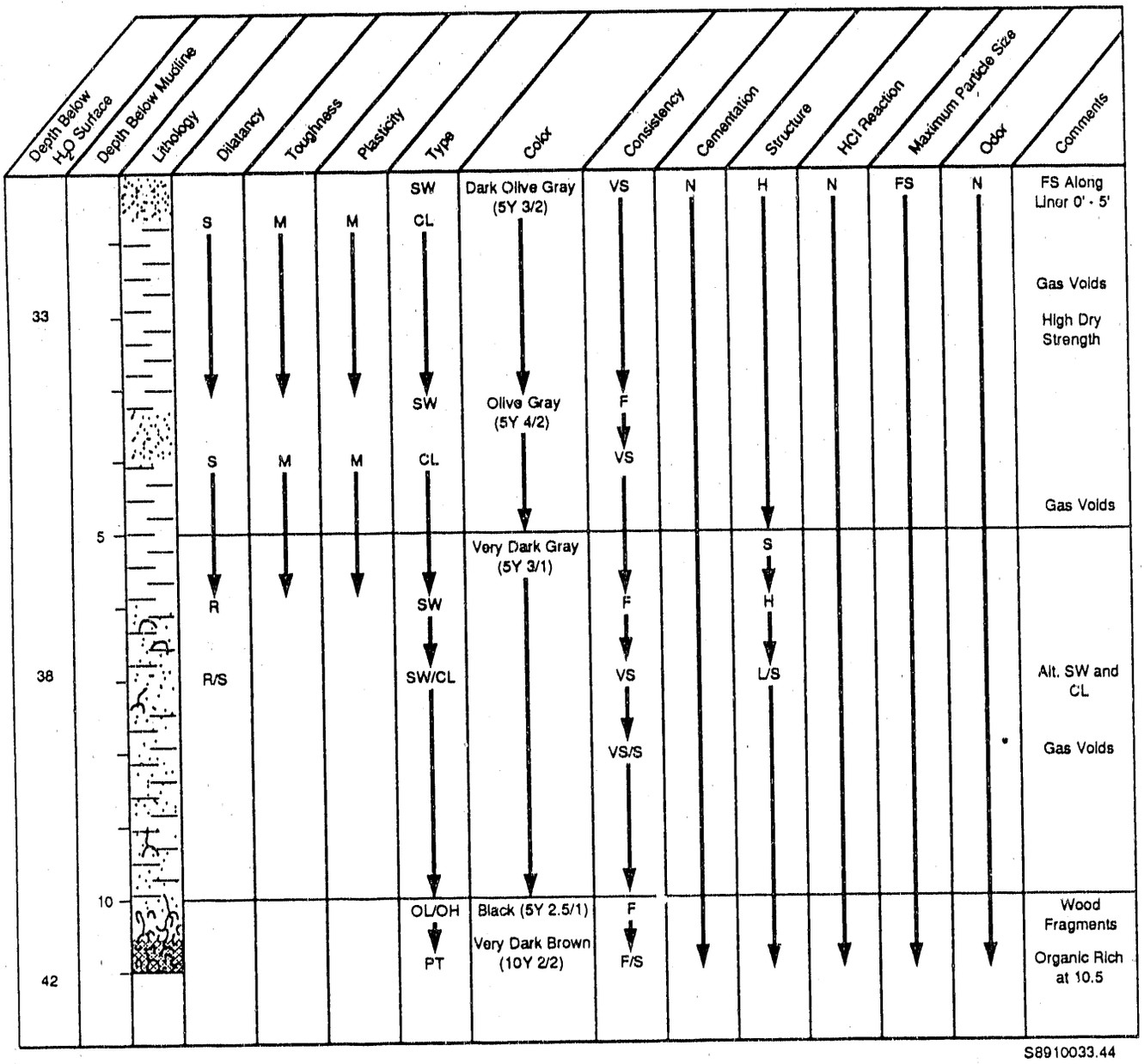
Core#: P XII.5 C
Date: 9-15-89
Page 1 of 1

Mudline = 41' MLLW
Core Length = 0' - 5'
5' - 7'



Core#: P XII.5 R
Date: 9-15-89
Page 1 of 1

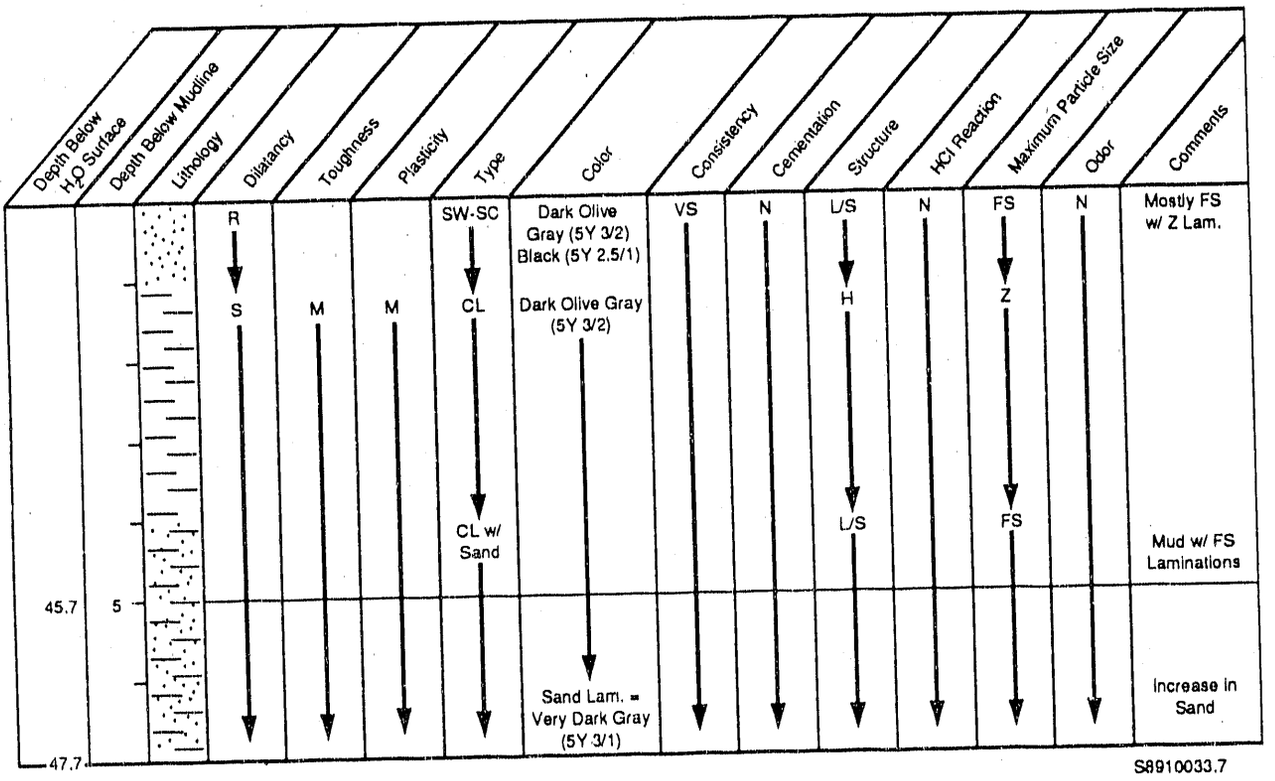
Mudline = 31.0' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 11.1'



S8910033.44

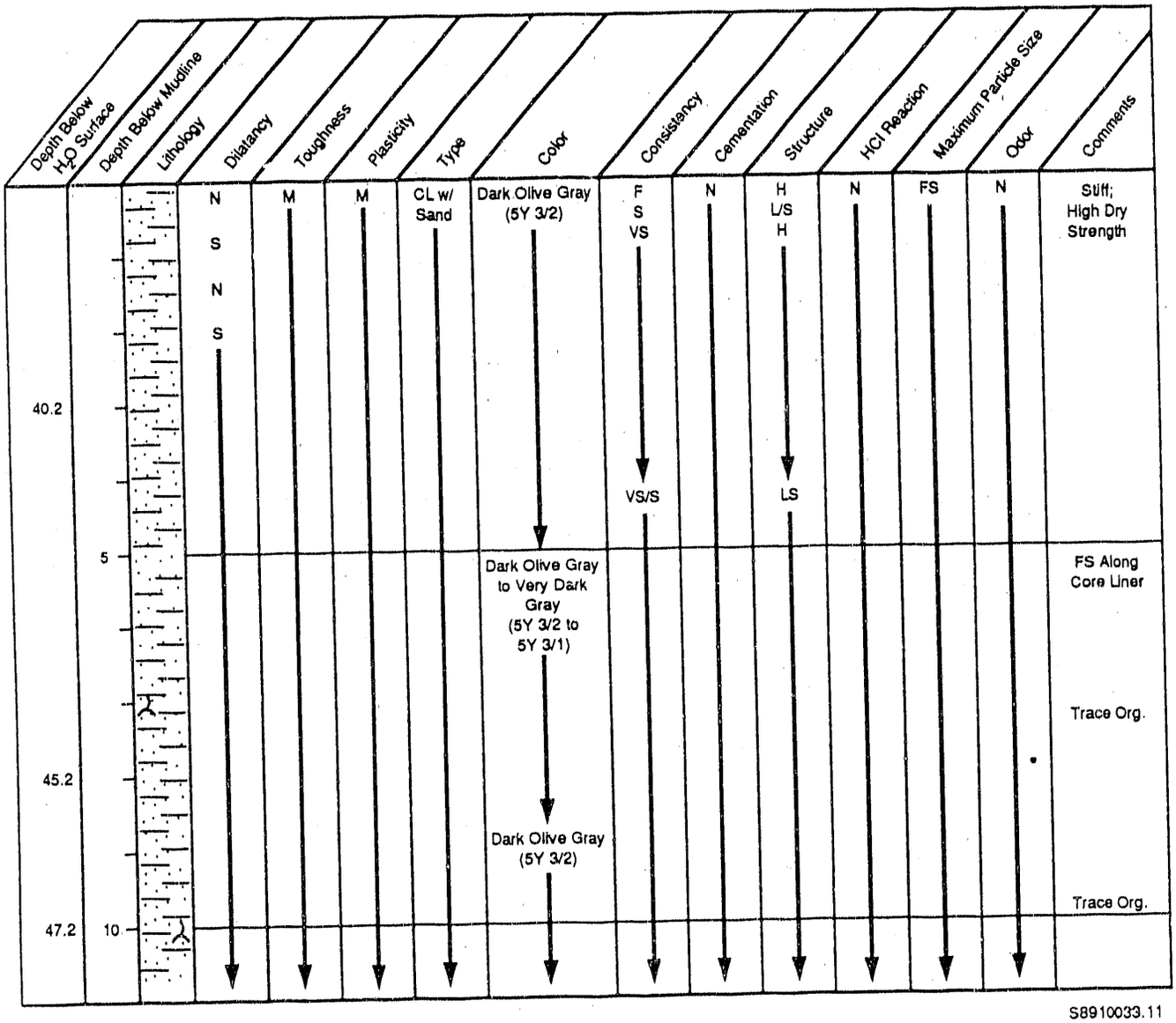
Core#: P XIII L
Date: 9-15-89
Page 1 of 1

Mudline = 40.7' MLLW
Core Length = 0' - 3.7'
3.7' - 6.7'



Core#: P XIII R
Date: 9-15-89
Page 1 of 1

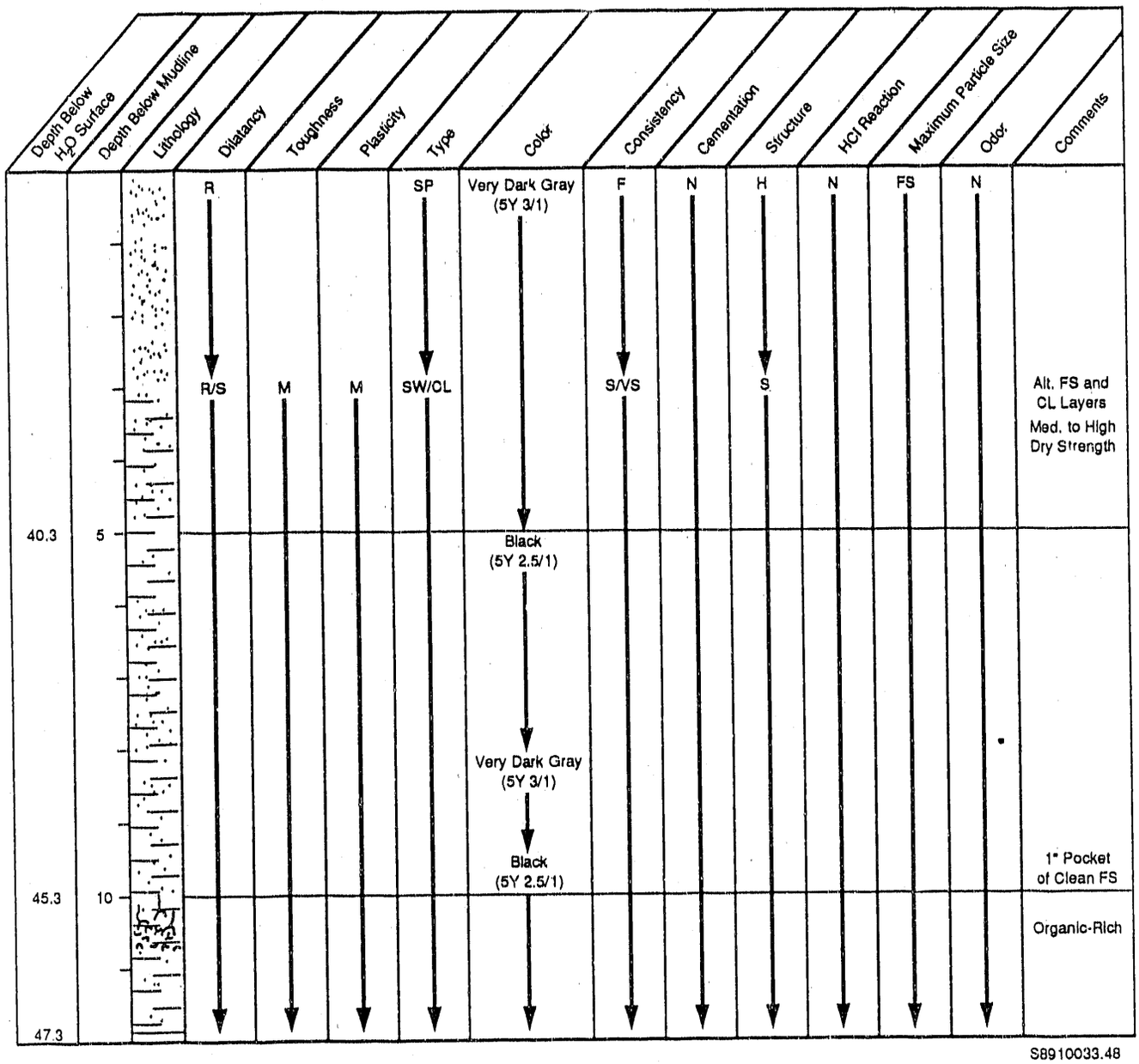
Mudline = 37.2' MLLW
Core Length = 0' - 5'
5' - 10.8'



S8910033.11

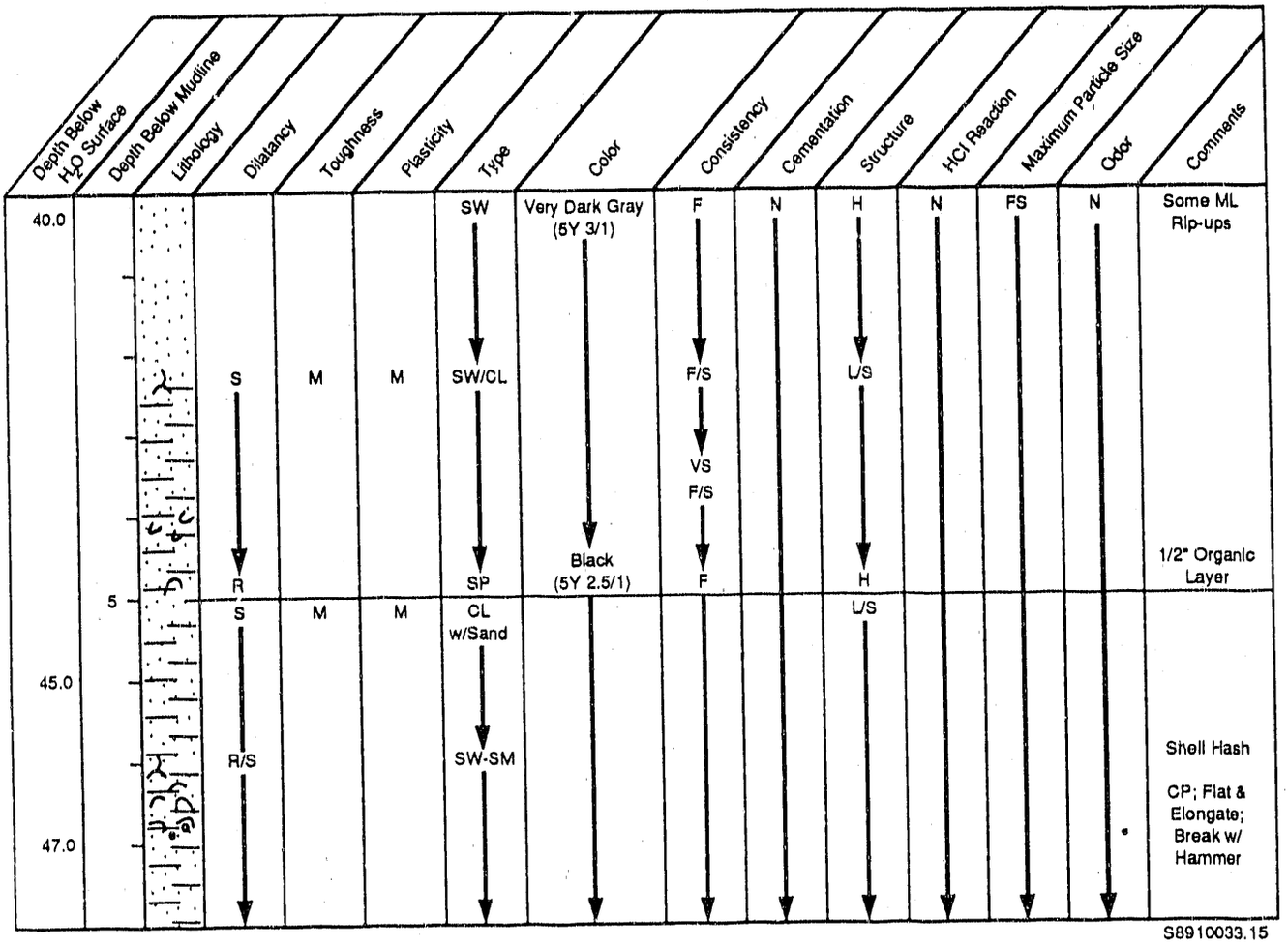
Core#: P XIII B3
Date: 9-15-89
Page 1 of 1

Mudline = 35.3' MLLW
Core Length = 0' - 5'
5' - 10'
10' - 11.8'



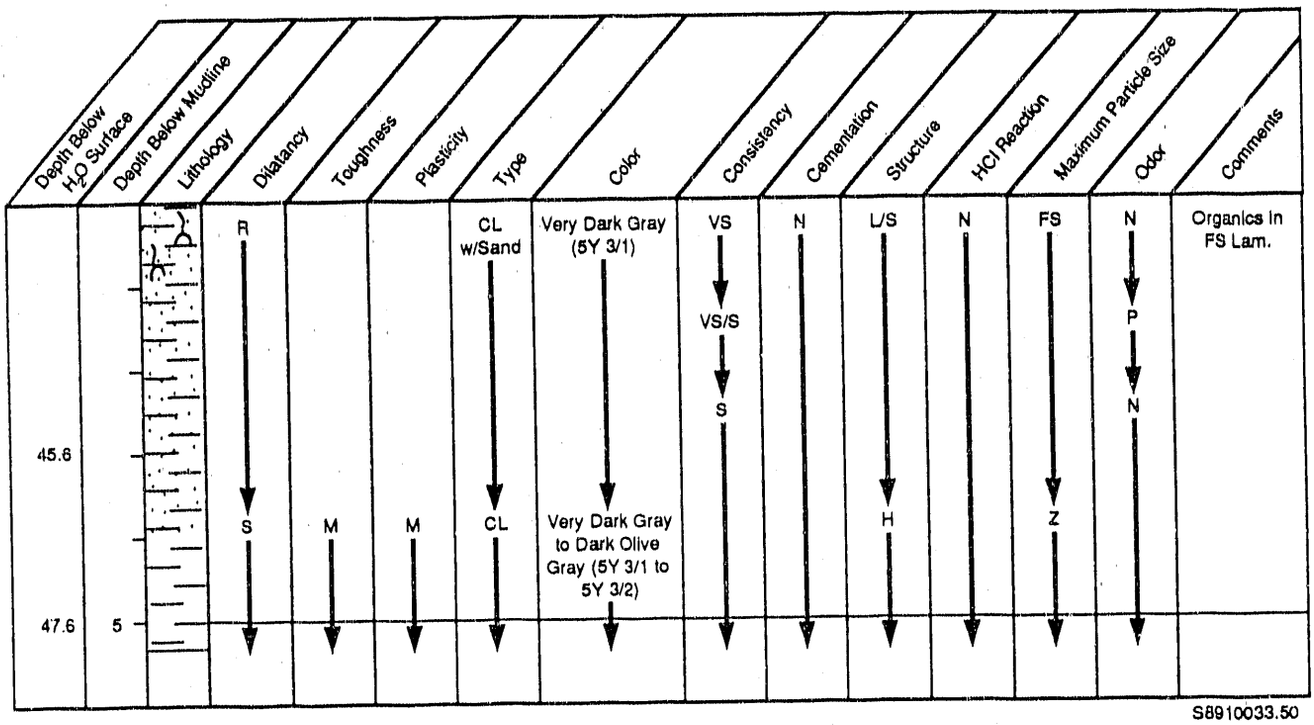
Core#: P XIII B4
Date: 9-15-89
Page 1 of 1

Mudline = 39.0' MLLW
Core Length = 0' - 5'
5' - 9'



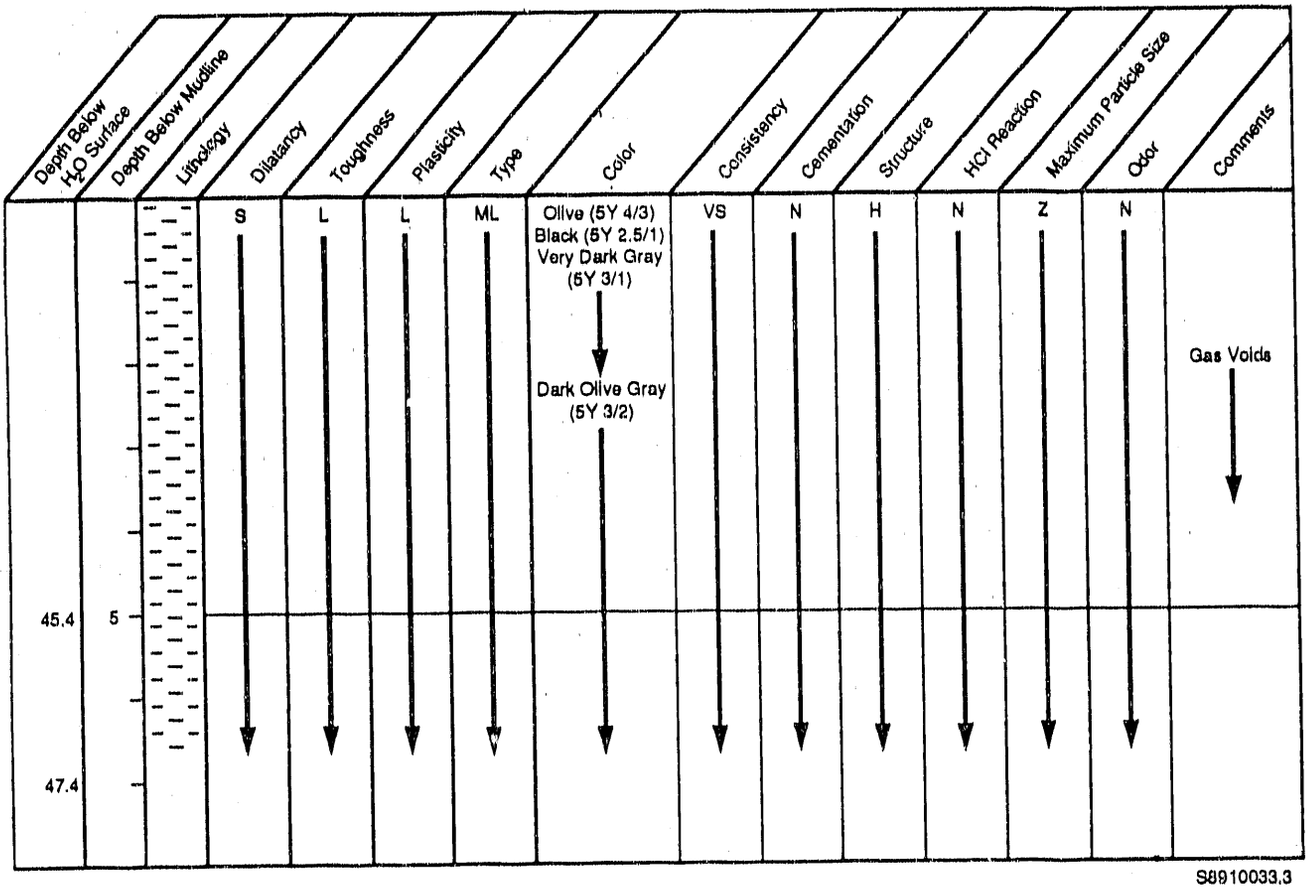
Core#: PXIV C
Date: 9-15-89
Page 1 of 1

Mudline = 42.6' MLLW
Core Length = 5.3'



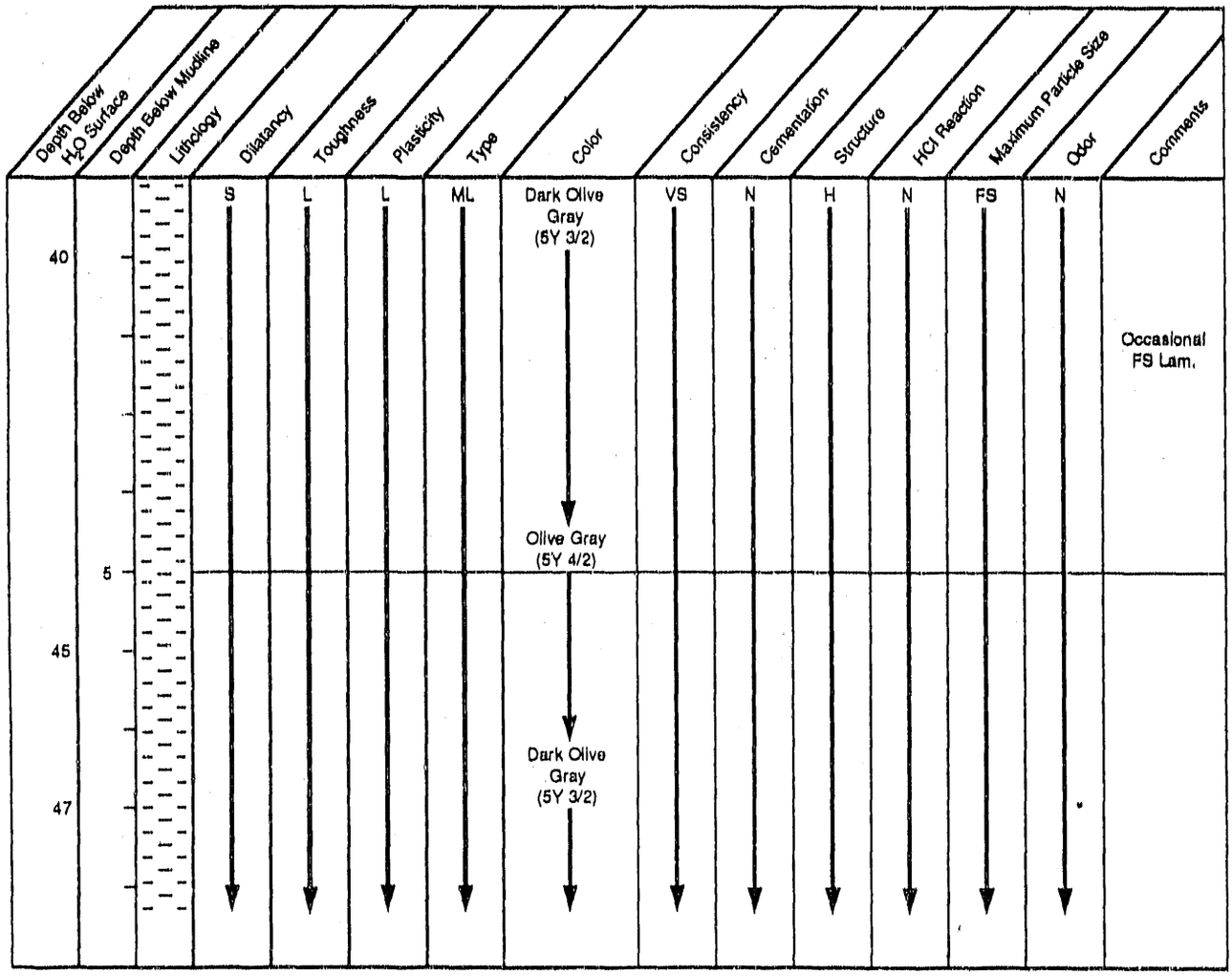
Core#: CBI
Date: 9-19-89
Page 1 of 1

Mudline = 40.4' MLLW
Core Length = 0' - 4'
4' - 6' 8"



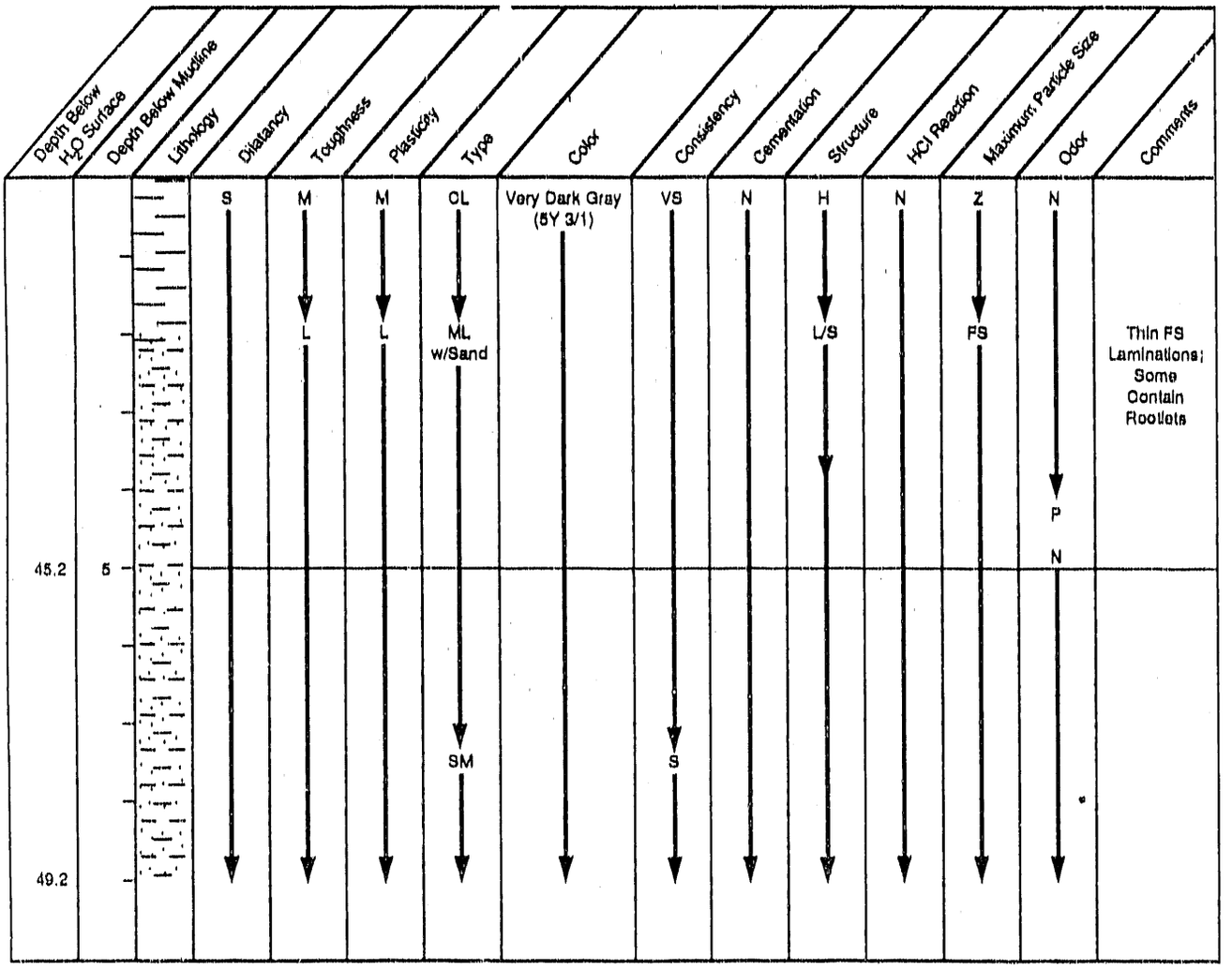
Core#: C I R
Date: 9-14-89
Page 1 of 1

Mudline = 39' MLLW
Core Length = 0' - 5'
5' - 9.35'



Core#: CB2
Date: 9-14-89
Page 1 of 1

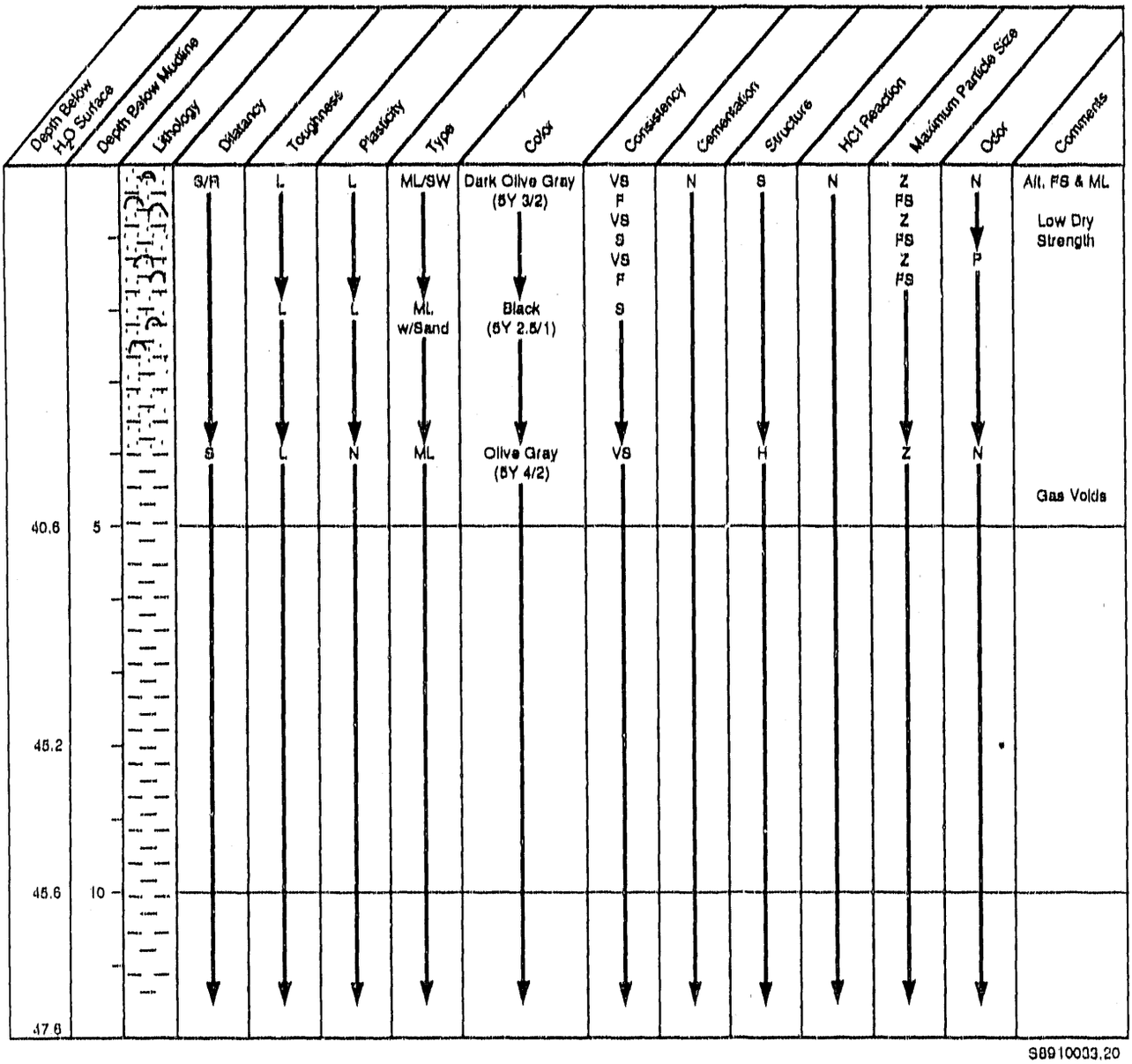
Mudline = 40.2' MLLW
Core Length = 0' - 4'
4' - 9'



S0910033.21

Core#: CB4 A
Date: 9-19-89
Page 1 of 1

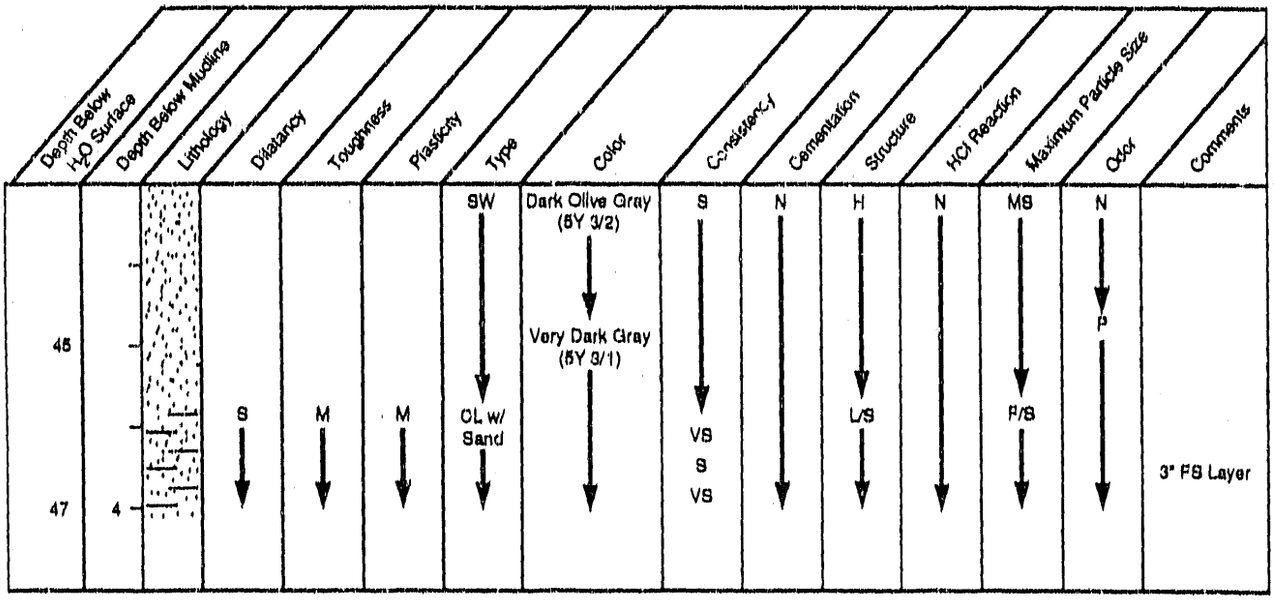
Mudline = 35.6' MLLW
Core Length = 0' - 6'
6' - 11'
11' - 11.6'



S89100033.20

Core#: CB5
Date: 9-14-89
Page 1 of 1

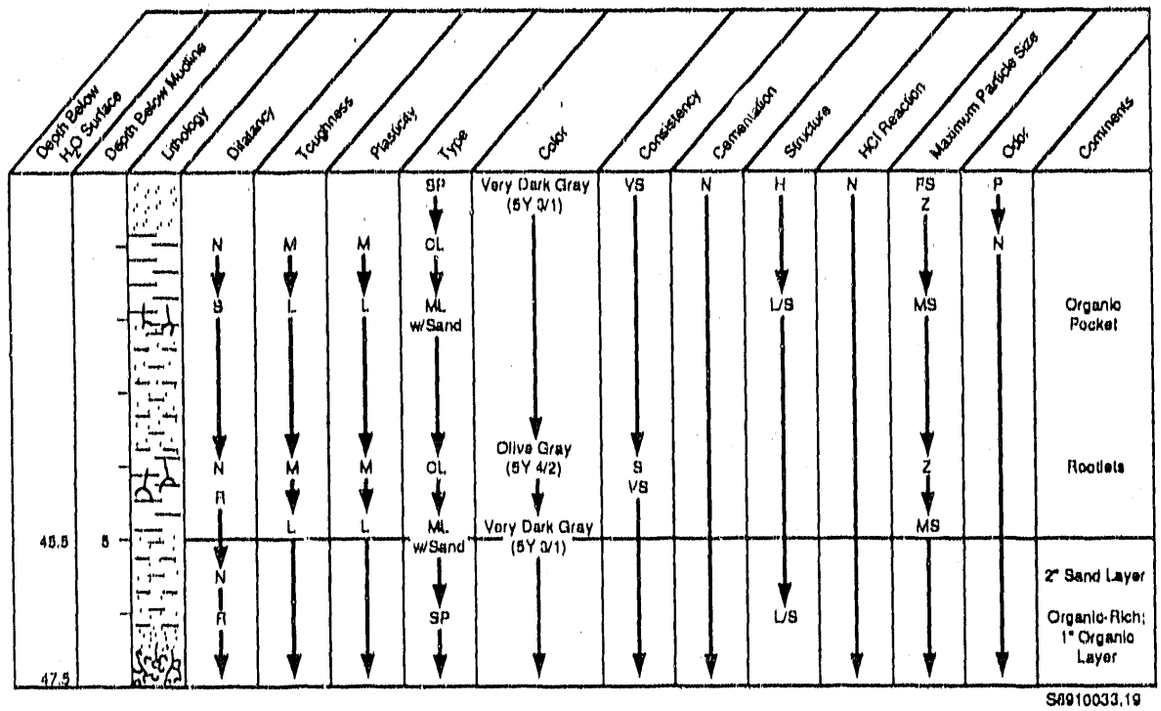
Mudline = 43' MLLW
Core Length = 0' - 4'



S8910033.12

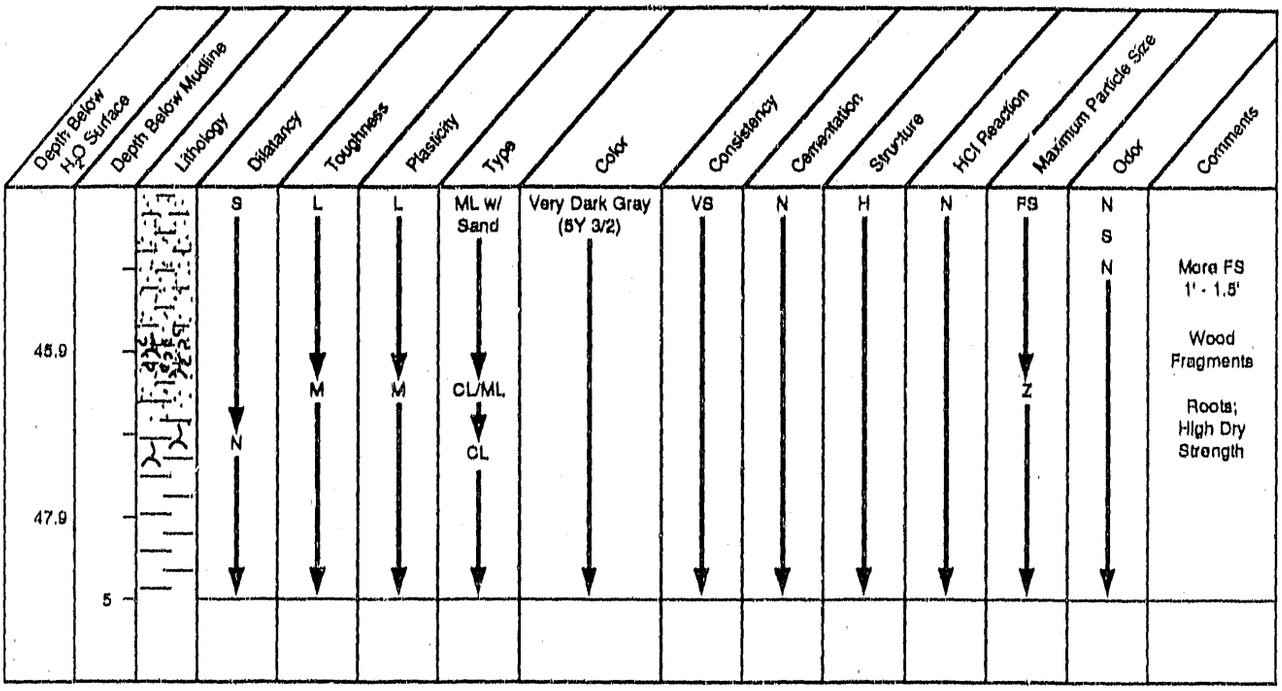
Core#: CB6
Date: 9-14-89
Page 1 of 1

Mudline = 40.5' MLLW
Core Length = 0' -4.8'
4.8' - 6.8"



Core#: CB7
Date: 9-15-89
Page 1 of 1

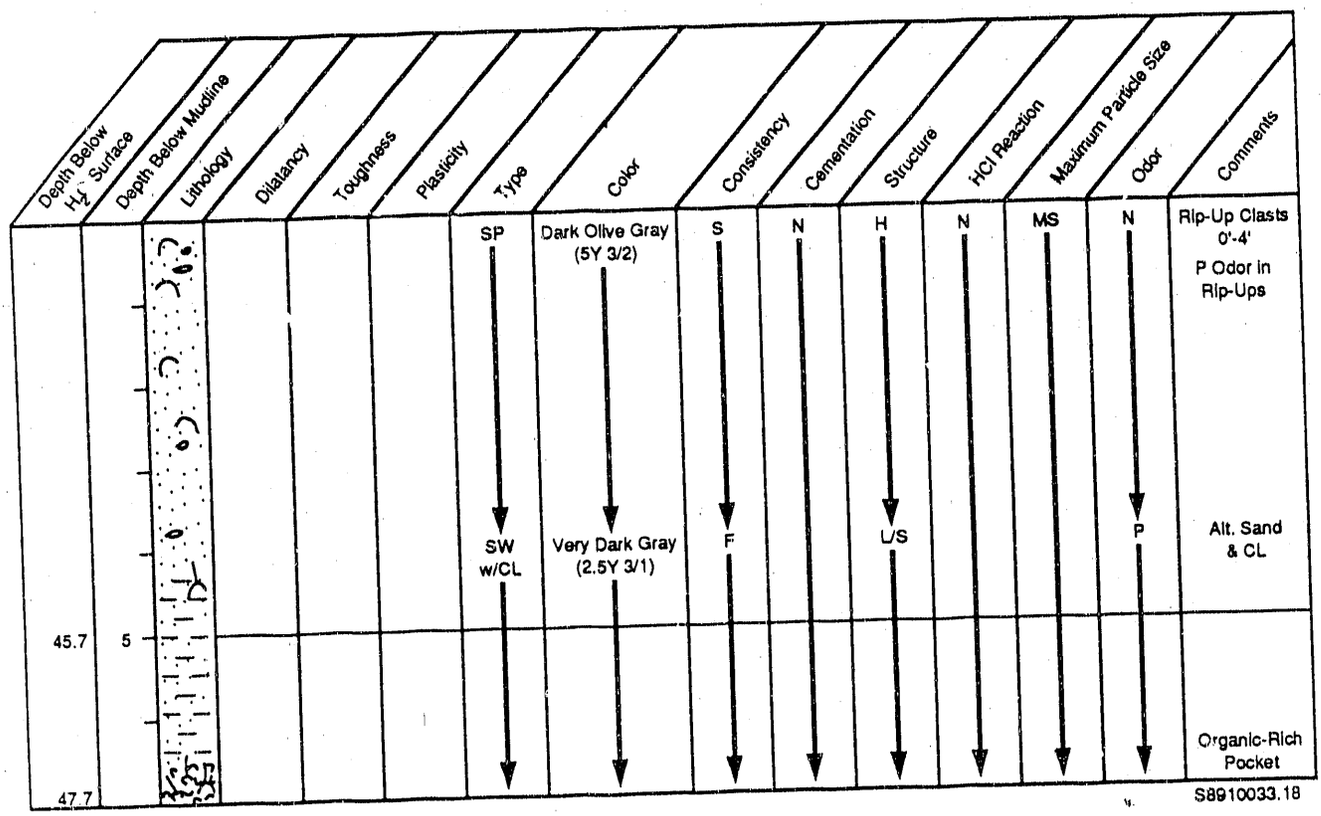
Mudline = 43.9' MLLW
Core Length = 4.8'



S8910033.6

Core#: C2C
Date: 9-14-89
Page 1 of 1

Mudline = 40.7' MLLW
Core Length = 0' -4'
4' - 6.7"



Core#: C2R
Date: 9-14-89
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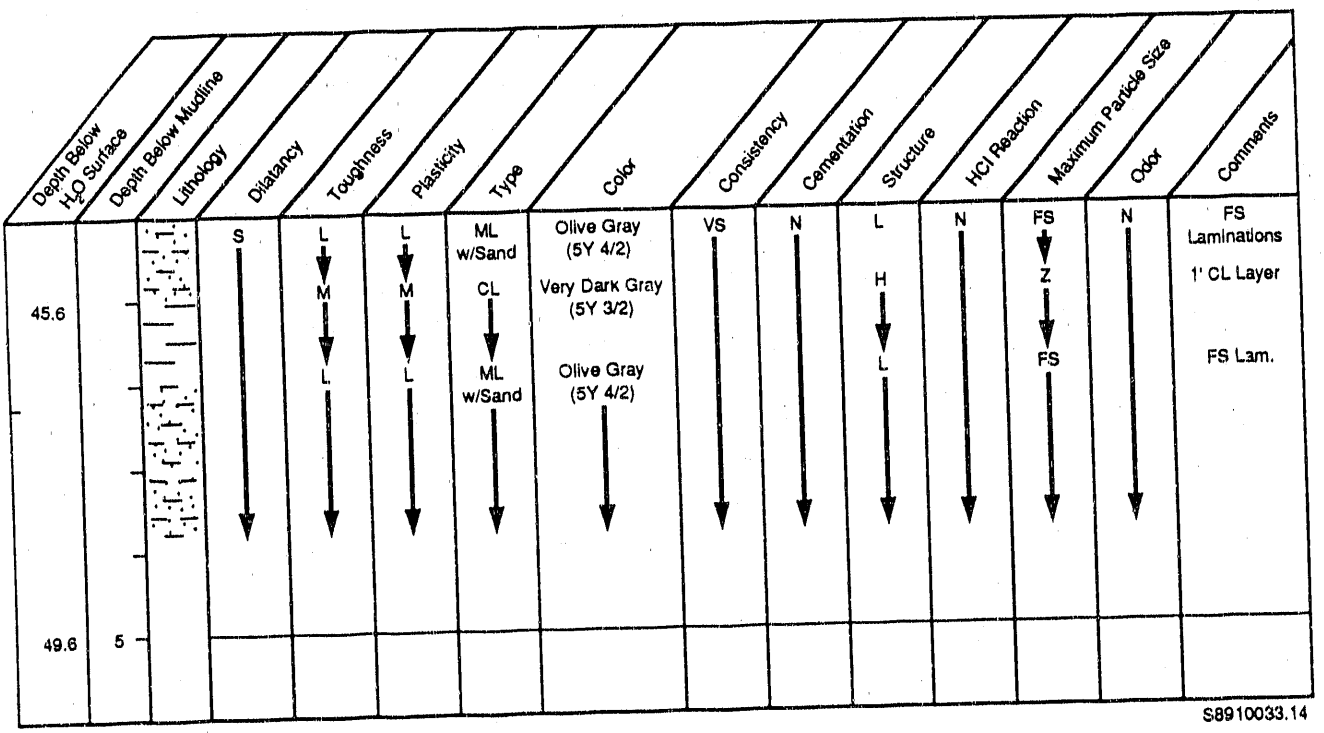
Mudline = 44.6' MLLW
Core Length = 3.8'



APPENDIX C

RESULTS OF SEDIMENT CHEMICAL ANALYSES

Table C.1. Results of Grain Size Analysis of John F. Baldwin Ship Channel Sediments

Station, Section (ft)		Percent at Size Fraction																
	phi	<-2.25	-2.25	-1.00	0.25	1.25	2	3.25	3.75	4	5	6	7	8	9	10	11	
	μm	>4750	4750-2000	2000-850	850-425	425-250	250-106	106-75	75-62.5	62.5-31.2	31.2-15.6	15.6-7.8	7.8-3.9	3.9-1.9	1.9-0.9	0.9-0.4	<0.4	<0.2
West Richmond																		
WR VII C	0-5.5	1	0	0	1	2	53	8	3	7	4	3	2	3	3	2	NA	N/A
WR VI L	0-4	0	0	0	1	2	42	12	3	8	4	2	4	2	3	3	NA	N/A
WR V L	0-6	0	1	1	1	8	23	5	2	7	8	7	5	7	6	5	NA	N/A
WR IV.5 C	0-4	0	1	1	1	8	31	4	2	9	6	5	6	5	6	4	10	1
WR IV.5 C	4-8	1	1	4	5	17	32	2	1	3	9	5	4	2	3	3	7	1
WR IV R	0-6	0	0	0	1	2	20	5	3	10	8	7	7	8	6	6	14	3
WR IV R	6-11.5 rep 1	0	1	0	1	14	49	3	0	5	6	3	3	3	2	10	NA	N/A
WR IV R	6-11.5 rep 2	0	1	1	1	14	47	3	1	5	5	3	4	2	3	3	7	N/A
WR III L	0-6.6	1	1	1	11	58	2	1	3	5	3	2	2	2	2	6	NA	N/A
WR III C	0-6.4	0	2	2	3	16	49	2	0	3	4	4	2	2	2	2	6	1
WR II L	0-6.9	0	3	3	2	16	49	2	1	6	4	3	1	2	2	6	NA	N/A
WR I R	0-5.1	0	1	1	2	8	28	7	3	9	7	4	5	4	4	4	11	2
Pinole Shoal																		
P I C	0-3	0	0	0	1	0	2	2	1	10	16	13	8	7	7	8	21	4
P II C	0-4.3	0	0	0	1	1	4	2	2	10	15	12	11	7	7	7	19	2
P III L	0-3	0	0	0	1	0	3	2	1	5	19	14	13	7	8	6	NR	N/A
P IV R	0-8	0	0	0	1	4	24	4	1	6	12	11	8	6	6	5	NR	N/A
P V L	0-8.4	0	0	0	0	2	8	4	1	5	14	13	10	8	8	6	18	3
P V C	0-8.7	0	0	0	1	1	7	3	1	8	16	13	11	7	5	7	17	3
P V R	0-5	0	0	0	0	3	17	4	1	7	10	10	10	8	8	5	NR	N/A
P V R	5-10.5	0	0	0	0	2	12	5	2	11	13	19	6	6	6	5	16	N/A
P VI L	0-5	0	0	0	1	3	11	2	1	4	8	9	13	12	11	9	15	1
P VI L	5-11.6	0	0	0	0	1	11	5	2	11	16	11	10	6	6	5	12	4
P VI C	0-9	0	0	1	2	7	47	8	2	5	6	5	3	3	4	2	5	N/A
P VI R	0-5	0	1	1	1	11	36	4	1	4	5	6	5	6	6	4	9	N/A

Table C.1. (Continued)

Station, Section (ft)		phi <-2.25 / μm >4750	-2.25 4750-2000	-1.00 2000-850	0.25 850-425	1.25 425-250	2 250-106	3.25 106-75	3.75 75-62.5	4 62.5-31.2	5 31.2-15.6	6 15.6-7.8	7 7.8-3.9	8 3.9-1.9	9 1.9-0.9	10 0.9-0.4	11 <0.4	<0.2
Percent at Size Fraction																		
Pinole Shoal, (cont'd)																		
P VI R	5-11.7	0	0	0	1	3	20	10	3	8	10	10	7	5	4	4	10	5
P VII C	0-5	0	0	0	1	7	34	7	2	5	7	6	5	5	4	4	10	3
P VII C	5-10.1	0	0	0	1	6	38	6	2	5	8	7	5	3	4	3	7	5
P VIII L	0-6.6	0	0	0	1	1	19	4	1	4	8	10	9	8	10	6	15	4
P VIII L	6.6-9.5	0	0	0	4	25	50	3	0	1	3	2	3	1	2	2	3	1
P VIII R	0-8	0	0	0	0	4	39	3	1	5	5	5	8	7	6	5	12	N/A
P VIII R	8-10.5	0	0	0	3	13	54	5	1	2	2	2	2	1	2	2	4	7
P VIII.5 C	0-3.6	0	0	0	2	13	68	3	1	1	1	2	3	0	2	2	2	N/A
P VIII.5 C	3.6-10.4 rep 1	0	0	0	1	3	54	9	2	3	6	5	5	1	2	2	5	2
P VIII.5 C	3.6-10.4 rep 2	0	0	0	1	3	54	8	2	5	5	4	4	2	3	2	5	2
P IX C	0-5	0	0	0	3	18	53	4	1	2	3	4	2	2	2	2	4	N/A
P IX C	5-11.8	0	0	0	3	15	58	5	1	3	2	2	3	1	2	2	3	N/A
P IX.5 L	0-5 rep 1	0	0	1	5	28	49	2	0	2	1	3	2	1	1	2	3	N/A
P IX.5 L	0-5 rep 2	0	0	1	5	28	50	1	1	1	2	2	2	1	2	1	3	N/A
P IX.5 L	5-10.1	0	0	0	1	9	75	3	0	1	2	1	2	1	2	1	2	N/A
P X R	0-6	0	0	0	1	15	68	2	0	1	1	2	2	2	2	4	N/A	N/A
P X R	6-11.5	0	0	0	0	6	76	5	0	2	2	2	1	1	2	2	1	N/A
P X.5 C	0-5	0	1	4	9	18	52	2	1	0	2	2	3	1	2	3	NR	N/A
P X.5 C	5-11	0	0	0	0	6	71	5	0	3	2	3	3	2	2	3	N/A	N/A
P XI L	0-3.5	1	0	0	1	6	51	4	0	3	4	6	5	4	4	10	NA	N/A
P XII R	0-8.5	0	1	0	0	1	28	4	1	6	7	9	9	9	7	18	NA	N/A
P XII RR	0-9.2	0	1	0	0	3	32	6	2	3	6	8	8	8	6	15	NA	N/A
P XII B2	0-2	0	0	0	0	4	84	3	0	1	1	1	1	1	1	1	2	N/A
P XII B2	2-7.5 rep 1	0	0	0	0	0	5	3	3	6	9	10	13	12	9	8	18	4
P XII B2	2-7.5 rep 2	0	0	0	1	4	3	3	10	9	9	13	12	9	6	20	1	NA
P XII B2	7.5-12.5	0	0	1	1	43	11	2	5	4	6	6	4	4	3	7	3	NA
P XII B1	0-5	0	1	0	1	1	14	4	1	4	6	11	10	10	10	9	17	1
P XII B1	5-11.1	0	1	0	0	1	26	7	2	2	9	7	9	7	7	6	14	2

Table C.1. (Continued)

Station, Section (ft)	phi / μm	<-2.25 >4750	-2.25 4750-2000	-1.00 2000-850	0.25 850-425	1.25 425-250	2 250-106	3.25 106-75	3.75 75-62.5	4 62.5-31.2	5 31.2-15.6	6 15.6-7.8	7 7.8-3.9	8 3.9-1.9	9 1.9-0.9	10 0.9-0.4	11 <0.4	<0.2
Pinole Shoal, (cont'd)																		
P XII.5 C	0-6 rep 1	0	0	0	1	2	13	5	2	9	9	10	11	9	8	19	2	N/A
P XII.5 C	0-6 rep 2	0	0	0	0	3	13	5	3	10	9	9	10	9	6	6	15	2
P XII.5 R	0-5.3	0	0	0	0	1	6	5	2	5	9	10	12	12	9	17	10	2
P XII.5 R	5.3-11.1	0	1	0	0	2	41	10	2	6	5	9	5	4	3	4	7	1
P XIII L	0-6 rep 1	0	0	0	0	1	9	6	3	8	9	10	12	10	7	7	14	4
P XIII L	0-6 rep 2	0	0	0	0	1	9	6	3	8	10	11	12	10	8	4	16	2
P XIII R	0-5	0	0	0	0	0	6	8	4	11	10	9	11	10	7	4	16	4
P XIII R	5-10	0	0	0	0	0	4	8	4	11	10	10	11	11	6	5	16	4
P XIV C	0-4.5	0	0	0	1	6	43	4	1	3	4	7	7	7	5	3	9	N/A
Carquinez Strait																		
CB 1	0-6.6	0	0	0	0	0	1	1	2	7	12	10	15	12	10	8	21	1
C I R	0-8 rep 1	0	0	0	0	0	1	2	1	9	15	14	13	10	10	8	16	1
C I R	0-8 rep 2	0	0	0	0	0	1	2	1	9	12	15	14	11	9	8	15	3
CB 4 A	0-3.8	0	0	0	1	5	26	6	1	5	7	7	9	8	6	6	12	1
CB 4 A	3.8-11.4	0	0	0	0	0	2	2	1	6	11	11	15	13	10	7	21	1
CB 5	0-4	0	0	1	2	4	23	5	1	3	8	9	10	8	8	5	11	2
CB 6	0-6.5	4	0	1	5	16	34	4	1	6	6	6	4	2	3	2	6	N/A
CB 7	0-3.1	0	0	2	1	2	16	8	3	8	9	9	8	7	7	2	16	2
C II C	0-4	0	0	0	2	39	51	2	0	0	1	1	1	1	1	1	0	N/A
C II C	4-6.8	0	0	1	0	13	58	2	1	1	2	4	4	4	3	1	5	1
C II R	0-2.4	0	0	0	0	1	9	5	1	7	9	11	15	11	8	15	6	2

NR - Analyzed, but no result for this grain size.
NA - Not analyzed.
N/A - Not applicable.

TABLE C.2. Total Oil and Grease (mg/kg dry weight), Petroleum Hydrocarbons (mg/kg dry weight), and Petroleum Hydrocarbon Fraction of Total Oil and Grease in John F. Baldwin Ship Channel Sediments

Station, Section (ft)		Oil & Grease	Petroleum Hydrocarbons	Petroleum Fraction (%)
West Richmond				
WR VII C	0-5.5	37	27	73
WR VI L	0-4	73	55	75
WR V L	0-6	79	74	94
WR IV.5 C	0-4	82	70	85
WR IV.5 C	4-8	18	16	89
WR IV R	0-6	167	112	67
WR IV R	6-11.5(a)	38	19	51
WR III L	0-6.6	61	11	18
WR III C	0-6.4	26	12	46
WR II L	0-6.9	20	5.8	29
WR I R	0-5.1	91	49	54
Pinole Shoal				
P I C	0-3	44	21	48
P II C	0-4.3	39	25	64
P III L	0-3	45	24	53
P IV R	0-8	34	22	65
P V L	0-8.4	53	40	75
P V C	0-8.7	33	24	73
P V R	0-5	45	28	62
P V R	5-10.5	93	21	23
P VI L	0-5	114	50	44
P VI L	5-11.6	41	24	59
P VI C	0-9	21	8.5	40
P VI R	0-5	63	39	62
P VI R	5-11.7	25	11	44
P VII C	0-5	98	32	33
P VII C	5-10.1	48	12	25
P VIII L	0-6.6	136	65	48
P VIII L	6.6-9.5	17	6.7	39
P VIII R	0-8	83	52	63
P VIII R	8-10.5	30	7.6	25
P VIII.5 C	0-3.6	41	13	32
P VIII.5 C	3.6-10.4(a)	9.4	7.0	74
P IX C	0-5	9.1	6.0	66
P IX C	5-11.8	8.5	8.6	101
P IX.5 L	0-5(a)	16	13	78
P IX.5 L	5-10.1	7.3	5.5	75
P X R	0-6	15	11	73
P X R	6-11.5	5.5	3.5	64

TABLE C.2. (Continued)

Station, Section (ft)		Oil & Grease	Petroleum Hydrocarbons	Petroleum Fraction
Pinole Shoal, cont'd				
P X.5 C	0-5	9.3	7.0	75
P X.5 C	5-11	12	7.6	63
P XI L	0-3.5	17	13	76
P XII R	0-8.5	19	9.1	48
P XII RR	0-9.2	45	33	73
P XII B2	0-2	17	15	88
P XII B2	2-7.5(a)	76	28	37
P XII B2	7.5-12.5	23	14	61
P XII B1	0-5	178	131	74
P XII B1	5-11.1	102	43	42
P XII.5 C	0-6(a)	15	8.7	58
P XII.5 R	0-5.3	21	14	67
P XII.5 R	5.3-11.1	24	15	63
P XIII L	0-6(a)	18	14	75
P XIII R	0-5	7.3	1.0	14
P XIII R	5-10	10	10	100
P XIV C	0-4.5	62	38	61
Carquinez Strait				
CB 1	0-6.6	61	32	52
C I R	0-8(a)	15	12	86
CB 4 A	0-3.8	111	59	53
CB 4 A	3.8-11.4	31	20	65
CB 5	0-4	33	23	70
CB 6	0-6.5	16	18	113
CB 7	0-3.1	104	62	60
C II C	0-4	9.1	14	154
C II C	4-6.8	55	52	95

(a) Reported concentration is the mean concentration of the compositing duplicates.

Table C.3. Metals in John F. Baldwin Ship Channel Sediments (<=not detected above given detection limit)

Station, Section (ft)		Concentration (mg/kg dry weight except Al)												
		Ag	Al (%)	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Shale soil(a)		0.10	8.0	6.6	0.30	20	100	57.0	0.4	95	20.0	0.60	1	80
Point Reyes Coarse(b)		0.04	NA	6.9	1.67	NA	315	9.8	0.09	42	7.7	0.31	0.44	36
Point Reyes Fine (c)		0.04	NA	7.2	0.63	NA	341	12.3	0.07	51	7.5	0.34	0.34	55
Detection Limits (DL)														
Target DL		0.1	0.001	2	0.1	0.1	2	2	0.02	2	2	0.1	0.1	2
Lowest Achieved DL		0.03	0.83	1.0	0.01	0.67	9	1	0.02	2	1.9	0.42	0.27	0.9
Maximum Achieved DL		0.03	0.83	1.0	0.01	0.67	9	1	0.02	2	1.9	0.89	0.42	0.9
West Richmond														
WR VII C	0-5.5	0.07	6.09	9.0	0.17	14.3	210	25.4	0.16	68	16.5	0.66	<0.42	73
WR VI L	0-4	0.11	6.53	11.6	0.22	15.6	197	28.9	0.26	73	13.3	<0.58	0.48	82
WR V L	0-6	0.24	6.89	11.5	0.33	17.4	207	41.3	0.25	87	28.1	<0.62	<0.42	114
WR IV.5 C	0-4	0.22	7.47	10.6	0.25	17.7	236	41.6	0.28	90	26.1	<0.61	<0.42	111
WR IV.5 C	4-8	0.04	6.58	14.4	0.17	19.6	171	24.6	0.07	87	7.6	<0.61	<0.42	69
WR IV R	0-6	0.36	7.45	12.3	0.30	15.2	226	48.5	0.38	102	32.3	<0.86	0.46	127
WR IV R	6-11.5(d)	0.09	6.93	10.9	0.14	17.6	225	24.9	0.08	95	10.4	<0.87	0.47	78
WR III L	0-6.6	0.05	7.27	8.9	0.10	17.6	205	23.8	0.02	94	7.2	<0.85	0.62	74
WR III C	0-6.4	0.04	6.02	10.3	0.12	16.6	220	24.1	0.02	93	7.7	<0.85	0.46	71
WR II L	0-6.9	0.04	5.86	8.7	0.10	16.6	208	22.1	0.25	91	5.6	<0.88	0.61	74
WR I R	0-5.1	0.19	7.38	9.4	0.23	17.9	375	38.0	0.20	98	23.8	<0.86	0.46	166
Pinole Shoal														
P I C	0-3	0.08	7.06	10.9	0.18	16.1	191	39.0	0.06	105	9.6	<0.85	0.46	96
P II C	0-4.3	0.09	7.70	11.2	0.19	11.1	179	45.6	0.05	108	8.3	<0.84	0.61	104
P III L	0-3	0.09	7.69	9.6	0.20	16.7	206	47.3	0.06	113	8.8	0.88	0.46	100
P IV R	0-8	0.08	7.09	8.4	0.17	11.3	253	33.7	0.06	103	8.9	<0.86	0.77	99

Table C.3. (Continued)

Station, Section (ft)		Concentration (mg/kg dry weight except Al)												
		Ag	Al (%)	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Pinole Shoal, cont'd														
P V L	0-8.4	0.16	8.48	10.5	0.27	12.1	237	56.1	0.16	117	17.1	<0.52	0.62	119
P V C	0-8.7	0.09	8.08	8.4	0.22	13.0	218	49.1	0.06	123	11.9	<0.52	0.47	102
P V R	0-5	0.12	8.15	13.2	0.25	12.5	247	58.8	0.18	124	13.1	<0.52	0.62	118
P V R	5-10.5	0.10	8.12	10.0	0.18	11.8	249	43.5	0.06	113	8.4	0.62	0.46	100
P VI L	0-5	0.27	8.70	17.0	0.48	15.4	278	77.7	0.38	146	28.5	<0.51	0.62	162
P VI L	5-11.6	0.10	8.06	8.6	0.18	12.3	207	48.0	0.06	117	9.7	<0.50	0.60	102
P VI C	0-9	0.08	7.14	8.5	0.13	13.4	239	31.3	0.02	105	10.4	<0.51	0.77	82
P VI R	0-5	0.15	7.80	10.4	0.22	13.8	256	44.8	0.14	116	18.2	<0.50	0.61	115
P VI R	5-11.7	0.08	8.48	9.6	0.16	13.6	239	44.0	0.05	112	7.8	<0.52	0.77	98
P VII C	0-5	0.12	7.36	12.0	0.23	14.2	267	47.4	0.16	113	15.7	<0.51	0.61	106
P VII C	5-10.1	0.07	7.42	9.4	0.15	14.6	210	36.6	0.03	106	7.9	<0.51	0.46	88
P VIII L	0-6.6	0.24	8.74	13.9	0.32	18.2	213	65.3	0.24	129	26.0	<0.86	0.77	140
P VIII L	6.6-9.5	0.04	7.09	8.6	0.09	18.5	281	25.6	0.03	98	9.3	<0.85	0.45	70
P VIII R	0-8	0.18	9.22	14.1	0.31	16.5	273	60.3	0.19	134	18.7	<0.88	0.62	133
P VIII R	8-10.5	0.06	6.74	18.7	0.13	15.5	242	36.5	0.03	97	8.2	<0.51	0.46	79
P VIII.5 C	0-3.6	0.05	6.58	12.1	0.10	18.0	248	24.0	0.04	100	13.5	<0.89	0.31	80
P VIII.5 C	3.6-10.4(d)	0.06	7.30	8.8	0.12	15.8	267	34.0	0.04	106	8.0	<0.86	0.54	84
P IX C	0-5	0.05	6.11	12.0	0.09	18.8	288	25.1	0.02	96	8.6	<0.85	0.62	75
P IX C	5-11.8	0.04	7.31	11.7	0.06	17.4	270	23.5	0.02	104	7.2	<0.88	0.31	71
P IX.5 L	0-5(d)	0.06	6.57	9.6	0.10	17.7	311	23.9	0.06	96	13.6	<0.86	0.39	75
P IX.5 L	5-10.1	0.04	7.61	8.1	0.08	19.9	276	21.9	0.02	105	9.5	<0.84	0.61	68
P X R	0-6	0.05	7.12	9.4	0.11	18.3	312	24.8	0.05	105	11.1	<0.84	0.62	83
P X R	6-11.5	0.04	7.36	13.2	0.08	18.9	393	25.6	0.02	113	8.2	<0.83	0.31	72
P X.5 C	0-5	0.07	7.16	12.4	0.09	18.3	313	23.8	0.03	99	9.2	<0.41	0.62	76
P X.5 C	5-11	0.04	6.85	9.9	0.09	18.2	333	29.3	0.03	99	7.2	<0.81	0.31	71
P XI L	0-3.5	0.14	8.13	10.2	0.17	16.7	345	39.7	0.10	112	10.2	<0.42	0.46	96
P XII R	0-8.5	0.05	9.06	14.3	0.13	17.2	331	46.5	0.26	108	11.8	<0.42	0.77	90
P XII RR	0-9.2	0.12	8.68	13.5	0.22	17.5	280	55.8	0.24	114	13.2	<0.41	0.31	115

Table C.3. (Continued)

Station, Section (ft)		Concentration (mg/kg dry weight except Al)												
		Ag	Al (%)	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Ti	Zn
Pinole Shoal, cont'd														
P XII B2	0-2	0.04	6.21	8.6	0.10	18.2	307	21.0	0.06	91	16.4	<0.86	0.31	83
P XII B2	2-7.5(d)	0.11	9.30	17.1	0.15	19.3	284	58.5	0.32	106	14.3	0.93	0.54	89
P XII B2	7.5-12.5	0.08	8.26	8.2	0.13	21.4	561	38.7	0.06	114	7.7	<0.86	0.62	92
P XII B1	0-5	0.23	8.86	14.0	0.43	22.9	247	75.0	0.24	122	24.0	<0.85	0.62	152
P XII B1	5-11.1	(e)	7.53	12.6	0.26	20.8	377	51.6	0.13	110	12.9	1.02	0.31	113
P XII.5 C	0-6(d)	0.08	9.35	16.9	0.19	16.4	242	53.9	0.37	97	15.4	<0.41	0.46	95
P XII.5 R	0-5.3	0 08	10.31	14.6	0.15	18.5	241	60.8	0.33	106	15.9	0.42	0.62	92
P XII.5 R	5.3-11.1	0.07	8.67	9.6	0.14	19.3	435	39.9	0.05	107	7.8	<0.41	0.61	93
P XIII L	0-6(d)	0.09	10.19	17.1	0.19	17.9	189	53.5	0.30	86	16.3	0.58	0.62	92
P XIII R	0-5	0.08	9.62	17.4	0.16	15.7	195	52.3	0.29	76	13.6	<0.42	0.61	88
P XIII R	5-10	0.06	9.50	16.8	0.16	17.1	207	55.0	0.37	95	12.2	<0.39	0.77	88
P XIV C	0-4.5	0.26	8.54	17.2	0.46	20.5	275	55.8	0.30	104	61.9	<0.63	0.31	136
Carquinez Strait														
CB 1	0-6.6	0.14	10.07	19.1	0.24	19.2	243	60.3	0.41	93	24.8	<0.83	0.77	102
C I R	0-8(d)	0.26	10.22	18.8	0.22	19.8	184	56.5	0.38	90	22.5	<0.60	0.69	102
CB 4 A	0-3.8	0.16	7.52	17.8	0.28	20.5	269	56.2	0.27	103	22.1	0.65	0.46	126
CB 4 A	3.8-11.4	0.09	9.75	19.1	0.15	20.6	230	57.3	0.38	120	15.0	<0.87	0.61	101
CB 5	0-4	0.05	7.59	9.9	0.15	19.8	204	29.4	0.13	89	14.7	<0.60	<0.42	86
CB 6	0-6.5	0.22	8.83	14.7	0.57	20.5	223	66.5	0.44	108	34.8	<0.59	<0.42	147
CB 7	0-3.1	0.27	8.00	14.1	0.36	19.2	206	61.7	0.22	108	24.9	0.96	0.62	132
C II C	0-4	0.03	6.16	8.4	0.09	18.2	190	17.6	0.06	81	10.4	<0.59	<0.42	71
C II C	4-6.8	0.07	7.26	16.4	0.34	20.6	249	33.1	0.18	99	17.5	<0.60	<0.42	164
C II R	0-2.4	0.06	11.21	21.4	0.19	19.4	164	54.2	0.45	80	13.6	<0.59	<0.42	84

(a) Krauskopf (1967).

(b) Mean of values reported by Word, et al. (1988), Word et al. (1989a), and Word et al. (1989b).

(c) Mean of values reported by Word, et al. (1989a) and Word et al. (1989b).

(d) Reported concentration is the mean concentration of compositing duplicate samples.

(e) Sample currently being reanalyzed.

Table C.4. Proportion of Trace Metals in John F. Baldwin Ship Channel Sediments Relative to Concentration Found in Shale Soils (N/A=not applicable)

Station, Section (ft)		Ag	Al	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
West Richmond														
WR VII C	0-5.5	0.7	0.8	1.4	0.6	0.7	2.1	0.4	0.4	0.7	0.8	1.1	N/A	0.9
WR VI L	0-4	1.1	0.8	1.8	0.7	0.8	2.0	0.5	0.7	0.8	0.7	N/A	0.5	1.0
WR V L	0-6	2.4	0.9	1.7	1.1	0.9	2.1	0.7	0.6	0.9	1.4	N/A	N/A	1.4
WR IV.5 C	0-4	2.2	0.9	1.6	0.6	0.9	2.4	0.7	0.7	0.9	1.3	N/A	N/A	1.4
WR IV.5 C	4-8	0.4	0.8	2.2	0.5	1.0	1.7	0.4	0.2	0.9	0.4	N/A	N/A	0.9
WR IV R	0-6	3.6	0.9	1.9	1.0	0.8	2.3	0.9	1.0	1.1	1.6	N/A	0.5	1.6
WR IV R	6-11.5	0.9	0.8	1.7	0.5	0.9	2.3	0.4	0.3	1.0	0.5	N/A	0.5	1.0
WR IV R	6-11.5	0.8	0.9	1.6	0.4	0.9	2.2	0.4	0.1	1.0	0.5	N/A	0.5	1.0
WR III L	0-6.6	0.5	0.9	1.4	0.3	0.9	2.1	0.4	0.1	1.0	0.4	N/A	0.6	0.9
WR III C	0-6.4	0.4	0.8	1.6	0.4	0.8	2.2	0.4	0.1	1.0	0.4	N/A	0.5	0.9
WR II L	0-6.9	0.4	0.7	1.3	0.3	0.8	2.1	0.4	0.6	1.0	0.3	N/A	0.6	0.9
WR I R	0-5.1	1.9	0.9	1.4	0.8	0.9	3.8	0.7	0.5	1.0	1.2	N/A	0.5	1.3
Pinole Shoal														
P I C	0-3	0.8	0.9	1.7	0.6	0.8	1.9	0.7	0.2	1.1	0.5	N/A	0.5	1.2
P II C	0-4.3	0.9	1.0	1.7	0.6	0.6	1.8	0.8	0.1	1.1	0.4	N/A	0.6	1.3
P III L	0-3	0.9	1.0	1.5	0.7	0.5	2.1	0.8	0.2	1.2	0.4	1.5	0.5	1.2
P IV R	0-8	0.8	0.9	1.3	0.6	0.6	2.5	0.6	0.2	1.1	0.4	N/A	0.8	1.1
P V L	0-8.4	1.6	1.1	1.5	0.9	0.6	2.4	1.0	0.4	1.2	0.9	N/A	0.5	1.5
P V C	0-8.7	0.9	1.0	1.3	0.7	0.7	2.2	0.9	0.2	1.3	0.6	N/A	0.5	1.3
P V R	0-5	1.2	1.0	2.0	0.8	0.6	2.5	1.0	0.5	1.3	0.7	N/A	0.6	1.5
P V R	5-10.5	1.0	1.0	1.5	0.6	0.6	2.5	0.8	0.2	1.2	0.4	1.0	0.5	1.2
P VI L	0-5	2.7	1.1	2.6	1.6	0.8	2.8	1.4	1.0	1.5	1.4	N/A	0.6	2.0
P VI L	5-11.6	1.6	1.0	1.3	0.6	0.6	2.1	0.8	0.2	1.2	0.5	N/A	0.6	1.3
P VI C	0-9	0.8	0.9	1.3	0.4	0.7	2.4	0.5	0.1	1.1	0.5	N/A	0.8	1.0
P VI R	0-5	1.5	1.2	1.6	0.7	0.7	2.6	0.8	0.4	1.2	0.9	N/A	0.6	1.4
P VI R	5-11.7	0.8	1.1	1.5	0.5	0.7	2.4	0.8	0.1	1.2	0.4	N/A	0.8	1.2

Table C.4. (Continued)

Station, Section (ft)		Ag	Al	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Pinole Shoal, cont'd														
P VII C	0-5	1.2	0.9	1.8	0.8	0.7	2.7	0.8	0.4	1.2	0.8	N/A	0.6	1.3
P VII C	5-10.1	0.7	0.9	1.4	0.5	0.7	2.1	0.6	0.1	1.1	0.4	N/A	0.5	1.1
P VIII L	0-6.6	2.4	1.1	2.1	1.1	0.9	2.1	1.1	0.6	1.4	1.3	N/A	0.8	1.8
P VIII L	6.6-9.5	0.4	0.9	1.3	0.3	0.9	2.8	0.4	0.1	1.0	0.5	N/A	0.5	0.9
P VIII R	0-8	1.8	1.2	2.1	1.0	0.8	2.7	1.1	0.5	1.4	0.9	N/A	0.6	1.7
P VIII R	8-10.5	0.6	0.8	2.8	0.4	0.8	2.4	0.5	0.1	1.0	0.4	N/A	0.5	1.0
P VIII.5 C	0-3.6	0.5	0.8	1.8	0.3	0.9	2.5	0.4	0.1	1.1	0.7	N/A	0.3	1.0
P VIII.5 C	3.6-10.4	0.5	1.0	1.4	0.4	0.8	2.4	0.7	0.1	1.2	0.3	N/A	0.5	1.0
P VIII.5 C	3.6-10.4	0.6	0.9	1.3	0.4	0.8	2.9	0.5	0.1	1.1	0.5	N/A	0.6	1.1
P IX C	0-5	0.5	0.8	1.8	0.3	0.9	2.9	0.4	0.1	1.0	0.4	N/A	0.6	0.9
P IX C	5-11.8	0.4	0.9	1.8	0.3	0.9	2.7	0.4	0.1	1.1	0.4	N/A	0.3	0.9
P IX.5 L	0-5	0.6	0.7	1.3	0.3	0.9	3.5	0.4	0.1	1.1	0.7	N/A	0.3	1.2
P IX.5 L	0-5	0.5	0.9	1.6	0.3	0.9	2.8	0.4	0.2	1.0	0.7	N/A	0.5	0.9
P IX.5 L	5-10.1	0.4	1.0	1.2	0.3	1.0	2.8	0.4	0.1	1.1	0.5	N/A	0.6	0.9
P X R	0-6	0.5	0.9	1.4	0.4	0.9	3.1	0.4	0.1	1.1	0.6	N/A	0.6	1.0
P X R	6-11.5	0.4	0.9	2.0	0.3	0.9	3.9	0.4	0.1	1.2	0.4	N/A	0.3	0.9
P X.5 C	0-5	0.7	0.9	1.9	0.3	0.9	3.1	0.4	0.1	1.0	0.5	N/A	0.6	0.9
P X.5 C	5-11	0.4	0.9	1.5	0.3	0.9	3.3	0.5	0.1	1.0	0.4	N/A	0.3	0.9
P XI L	0-3.5	1.4	1.0	1.5	0.6	0.9	3.5	0.7	0.3	1.2	0.5	N/A	0.5	1.2
P XII R	0-8.5	0.5	1.1	2.2	0.4	0.9	3.3	0.8	0.7	1.1	0.6	N/A	0.8	1.1
P XII RR	0-9.2	1.2	1.1	2.0	0.7	0.9	2.8	1.0	0.6	1.2	0.7	N/A	0.3	1.4
P XII B2	0-2	0.4	0.8	1.3	0.3	0.9	3.1	0.4	0.2	1.0	0.8	N/A	0.3	1.0
P XII B2	2-7.5	0.8	1.2	2.5	0.5	0.9	2.9	1.1	0.8	1.1	0.7	N/A	0.6	1.1
P XII B2	2-7.5	1.4	1.1	2.7	0.5	1.0	2.8	1.0	0.8	1.1	0.7	1.6	0.5	1.1
P XII B2	7.5-12.5	0.8	1.0	1.2	0.4	1.1	5.6	0.7	0.2	1.2	0.4	N/A	0.6	1.1
P XII B1	0-5	2.3	1.1	2.1	1.4	1.1	2.5	1.3	0.6	1.3	1.2	N/A	0.6	1.9
P XII B1	5-11.1	---	0.9	1.9	0.9	1.0	3.8	0.9	0.3	1.2	0.6	1.7	0.3	1.4
P XII.5 C	0-6	0.8	1.2	2.5	0.8	0.8	2.3	1.0	1.0	1.0	0.9	N/A	0.5	1.2
P XII.5 C	0-6	0.7	1.1	2.5	0.5	0.8	2.5	0.9	0.9	1.0	0.8	N/A	0.5	1.2

Table C.4. (Continued)

Station, Section (ft)		Ag	Al	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Pinole Shoal, cont'd														
P XII.5 R	0-5.3	0.6	1.3	2.2	0.5	0.9	2.4	1.1	0.8	1.1	0.8	0.42	0.6	1.2
P XII.5 R	5.3-11.1	0.7	1.1	1.5	0.5	1.0	4.4	0.7	0.1	1.1	0.4	N/A	0.6	1.2
P XIII L	0-6	0.9	1.3	2.6	0.6	0.9	1.9	0.9	0.7	0.9	0.8	1.0	0.6	1.1
P XIII L	0-6	0.9	1.3	2.5	0.6	0.9	1.9	0.9	0.7	0.9	0.8	N/A	0.6	1.2
P XIII R	0-5	0.6	1.2	2.6	0.5	0.8	2.0	0.9	0.7	0.8	0.7	N/A	0.6	1.1
P XIII R	5-10	0.8	1.2	2.8	0.5	0.9	2.1	1.0	0.9	1.0	0.6	N/A	0.8	1.1
P XIV C	0-4.5	2.6	1.1	2.6	1.5	1.0	2.8	1.0	0.7	1.1	3.1	N/A	0.3	1.7
Carquinez Strait														
CB 1	0-6.6	1.4	1.3	2.9	0.8	1.0	2.4	1.1	1.0	1.0	1.2	N/A	0.8	1.3
C I R	0-8	3.8	1.3	2.8	0.8	1.0	1.9	1.0	0.9	1.0	1.0	N/A	0.8	1.3
C I R	0-8	1.3	1.2	2.9	0.7	0.9	1.8	1.0	1.0	0.9	1.2	N/A	0.6	1.3
CB 4 A	0-3.8	1.6	0.9	2.7	0.9	1.0	2.7	1.0	0.7	1.1	1.1	1.4	0.5	1.6
CB 4 A	3.8-11.4	0.9	1.2	2.9	0.5	1.0	2.3	1.2	1.0	1.3	0.8	N/A	0.6	1.3
CB 5	0-4	0.5	0.9	1.5	0.5	1.0	2.0	0.5	0.3	0.9	0.7	N/A	N/A	1.1
CB 6	0-6.5	2.2	1.1	2.2	1.9	1.0	2.2	1.2	1.1	1.1	1.7	N/A	N/A	1.8
CB 7	0-3.1	2.7	1.0	2.1	1.2	1.0	2.1	1.1	0.6	1.1	1.2	1.6	0.6	1.7
C II C	0-4	0.3	0.8	1.3	0.3	0.9	1.9	0.3	0.2	0.8	0.5	N/A	N/A	0.9
C II C	4-6.8	0.7	0.9	2.5	1.1	1.0	2.5	0.6	0.5	1.6	0.9	N/A	N/A	1.3
C II R	0-2.4	0.6	1.4	3.2	0.6	1.0	1.6	1.0	1.1	0.8	0.7	N/A	N/A	1.6

Table C.5. Proportion of Metals in John F. Baldwin Ship Channel Sediments Relative to Concentration Found in Point Reyes Coarse Sediment (N/A=Not applicable)

Station, Section (ft)		Ag	Al	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
West Richmond														
WR VII C	0-5.5	1.6	N/A	1.3	0.1	N/A	0.7	2.6	1.9	1.6	2.1	2.1	N/A	2.0
WR VI '	0-4	2.8	N/A	1.7	0.1	N/A	0.6	2.9	3.1	1.8	1.7	N/A	1.1	2.3
WR V L	0-6	6.0	N/A	1.7	0.2	N/A	0.7	4.2	2.9	2.1	3.6	N/A	N/A	3.1
WR IV.5 C	0-4	5.5	N/A	1.5	0.1	N/A	0.7	4.2	3.3	2.1	3.4	N/A	N/A	3.1
WR IV.5 C	4-8	1.0	N/A	2.1	0.1	N/A	0.5	2.5	0.8	2.1	1.0	N/A	N/A	1.9
WR IV R	0-6	9.0	N/A	1.8	0.2	N/A	0.7	4.9	4.5	2.4	4.2	N/A	1.0	3.5
WR IV R	6-11.5	2.3	N/A	1.7	0.1	N/A	0.7	2.6	1.3	2.3	1.4	N/A	1.0	2.2
WR IV R	6-11.5	2.0	N/A	1.5	0.1	N/A	0.7	2.5	0.6	2.3	1.3	N/A	1.1	2.1
WR III L	0-6.6	1.3	N/A	1.3	0.1	N/A	0.7	2.4	0.2	2.3	0.9	N/A	1.4	2.0
WR III C	0-6.4	1.0	N/A	1.5	0.1	N/A	0.7	2.5	0.2	2.2	1.0	N/A	1.0	2.0
WR II L	0-6.9	1.0	N/A	1.3	0.1	N/A	0.7	2.3	2.9	2.2	0.7	N/A	1.4	2.0
WR I R	0-5.1	4.8	N/A	1.4	0.1	N/A	1.2	3.9	2.4	2.4	3.1	N/A	1.0	2.9
Pinole Shoal														
P I C	0-3	2.0	N/A	1.6	0.1	N/A	0.6	4.0	0.7	2.5	1.2	N/A	1.0	2.7
P II C	0-4.3	2.3	N/A	1.6	0.1	N/A	0.6	4.6	0.6	2.6	1.1	N/A	1.4	2.9
P III L	0-3	2.3	N/A	1.4	0.1	N/A	0.7	4.8	0.7	2.7	1.1	2.8	1.0	2.8
P IV R	0-8	2.0	N/A	1.2	0.1	N/A	0.8	3.4	0.7	2.5	1.2	N/A	1.8	2.5
P V L	0-8.4	4.0	N/A	1.4	0.2	N/A	0.6	5.7	1.9	2.8	2.2	N/A	1.4	3.3
P V C	0-8.7	3.3	N/A	1.2	0.1	N/A	0.7	5.0	0.7	3.0	1.5	N/A	1.1	2.8
P V R	0-5	3.0	N/A	1.9	0.1	N/A	0.8	6.0	2.1	3.0	1.7	N/A	1.4	3.2
P V R	5-10.5	2.5	N/A	1.4	0.1	N/A	0.8	4.4	0.7	2.7	1.1	2.0	1.0	2.8
P VI L	0-5	6.8	N/A	2.5	0.3	N/A	0.9	7.9	4.5	3.5	3.7	N/A	1.4	4.5
P VI L	5-11.6	2.5	N/A	1.2	0.1	N/A	0.7	4.9	0.7	2.8	1.3	N/A	1.4	2.8
P VI C	0-9	2.0	N/A	1.2	0.1	N/A	0.8	3.2	0.2	2.5	1.4	N/A	1.8	2.3
P VI R	0-5	3.8	N/A	1.5	0.1	N/A	0.8	4.6	1.6	2.8	2.4	N/A	1.4	3.2
P VI R	5-11.7	2.0	N/A	1.4	0.1	N/A	0.8	4.5	0.6	2.7	1.0	N/A	1.8	2.7
P VII C	0-5	3.0	N/A	1.7	0.1	N/A	0.8	4.8	1.9	2.7	2.0	N/A	1.4	2.9
P VII C	5-10.1	1.8	N/A	1.4	0.1	N/A	0.7	3.7	0.4	2.5	1.0	N/A	1.0	2.4

Table C.5. (Continued)

Station, Section (ft)		Ag	Al	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Finole Shoal, cont'd														
F VIII L	0-6.6	6.0	N/A	2.0	0.2	N/A	0.7	6.7	2.8	3.1	3.5	N/A	1.8	3.9
F VIII.5 C	3.6-10.4	1.5	N/A	1.2	0.1	N/A	0.9	3.1	0.4	2.4	1.2	N/A	1.4	2.3
F IX C	0-5	1.3	N/A	1.7	0.1	N/A	0.9	2.6	0.2	2.3	1.1	N/A	1.4	2.1
F IX C	5-11.8	1.0	N/A	1.7	0.0	N/A	0.9	2.4	0.2	2.5	0.9	N/A	0.7	2.0
F IX.5 L	0-5	1.5	N/A	1.2	0.1	N/A	1.1	2.6	0.6	2.4	1.7	N/A	0.7	2.1
F IX.5 L	0-5	1.3	N/A	1.5	0.1	N/A	0.9	2.3	0.7	2.2	1.8	N/A	1.0	2.0
F IX.5 L	5-10.1	1.0	N/A	1.2	0.0	N/A	0.9	2.2	0.2	2.5	1.2	N/A	1.4	1.9
F X R	0-6	1.3	N/A	1.4	0.1	N/A	1.0	2.5	0.6	2.5	1.4	N/A	1.4	2.3
F X R	6-11.5	1.0	N/A	1.9	0.0	N/A	1.2	2.6	0.2	2.7	1.1	N/A	0.7	2.0
F X.5 C	0-5	1.8	N/A	1.8	0.1	N/A	1.0	2.4	0.4	2.4	1.2	N/A	1.4	2.1
F X.5 C	5-11	1.0	N/A	1.4	0.1	N/A	1.1	3.0	0.4	2.4	0.9	N/A	0.7	1.9
F XI L	0-3.5	3.5	N/A	1.5	0.1	N/A	1.1	4.1	1.2	2.7	1.3	N/A	1.0	2.7
F XII R	0-8.5	1.3	N/A	2.1	0.1	N/A	1.1	4.7	3.1	2.6	1.5	N/A	1.8	2.5
F XII RR	0-9.2	3.0	N/A	2.0	0.1	N/A	0.9	5.7	2.8	2.7	1.7	N/A	0.7	3.2
F XII B2	0-2	1.0	N/A	1.2	0.1	N/A	1.0	2.1	0.7	2.2	2.1	N/A	0.7	2.3
F XII B2	2-7.5	2.0	N/A	2.4	0.1	N/A	0.9	6.3	3.6	2.5	1.9	N/A	1.4	2.5
F XII B2	2-7.5	3.5	N/A	2.5	0.1	N/A	0.9	5.7	3.9	2.6	1.8	3.0	1.0	2.4
F XII B2	7.5-12.5	2.0	N/A	1.2	0.1	N/A	1.8	3.9	0.7	2.7	1.0	N/A	1.4	2.5
F XII B1	0-5	5.8	N/A	2.0	0.3	N/A	0.8	7.7	2.8	2.9	3.1	N/A	1.4	4.2
F XII B1	5-11.1	---	N/A	1.8	0.2	N/A	1.2	5.3	1.5	2.6	1.7	3.3	0.7	3.1
F XII.5 C	0-6	2.0	N/A	2.5	0.1	N/A	0.7	5.8	4.6	2.3	2.2	N/A	1.0	2.7
F XII.5 C	0-6	1.8	N/A	2.4	0.1	N/A	0.8	5.2	4.0	2.4	2.0	N/A	1.0	2.6
F XII.5 R	0-5.3	2.0	N/A	2.1	0.1	N/A	0.8	6.2	3.9	2.5	2.1	0.42	1.4	2.5
F XII.5 R	5.3-11.1	1.8	N/A	1.4	0.1	N/A	1.4	4.1	0.6	2.6	1.0	N/A	1.4	2.6
F XIII L	0-6	2.3	N/A	2.5	0.1	N/A	0.6	5.4	3.5	2.1	2.1	1.9	1.4	2.5
F XIII L	0-6	2.3	N/A	2.4	0.1	N/A	0.6	5.5	3.4	2.0	2.2	N/A	1.4	2.6
F XIII R	0-5	2.0	N/A	2.5	0.1	N/A	0.6	5.3	3.4	1.8	1.8	N/A	1.4	2.4
F XIII R	5-10	2.0	N/A	2.7	0.1	N/A	0.7	5.6	4.4	2.3	1.6	N/A	1.8	2.4
F XIV C	0-4.5	6.5	N/A	2.5	0.3	N/A	0.9	5.7	3.5	2.5	8.0	N/A	0.7	3.7

Table C.5. (Continued)

Station, Section (ft)		Ag	Al	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Carquinez Strait														
CB 1	0-6.6	3.5	N/A	2.8	0.1	N/A	0.8	6.2	4.8	2.2	3.2	N/A	1.8	2.8
C I R	0-8	9.5	N/A	2.6	0.1	N/A	0.6	5.8	4.2	2.2	2.7	N/A	1.8	2.8
C I R	0-8	3.3	N/A	2.8	0.1	N/A	0.6	5.7	4.7	2.1	3.1	N/A	1.4	2.8
CB 4 A	0-3.8	4.0	N/A	2.6	0.2	N/A	0.9	5.7	3.2	2.5	2.9	2.7	1.0	3.5
CB 4 A	3.8-11.4	2.3	N/A	2.8	0.1	N/A	0.7	6.9	4.5	2.9	1.9	N/A	1.4	2.8
CB 5	0-4	1.3	N/A	1.4	0.1	N/A	0.6	3.0	1.5	2.1	1.9	N/A	N/A	2.4
CB 6	0-6.5	5.5	N/A	2.1	0.3	N/A	0.7	6.8	5.2	2.6	4.5	N/A	N/A	4.1
CB 7	0-3.1	6.8	N/A	2.0	0.2	N/A	0.7	6.3	2.6	2.6	3.2	3.1	1.4	3.6
C II C	0-4	0.8	N/A	1.2	0.1	N/A	0.6	1.8	0.7	1.9	1.4	N/A	N/A	2.0
C II C	4-6.8	1.8	N/A	2.4	0.2	N/A	0.8	3.4	2.1	2.4	2.3	N/A	N/A	2.9
C II R	0-2.4	1.5	N/A	3.1	0.1	N/A	0.5	5.5	5.3	1.9	1.8	N/A	N/A	2.3

Table C.6. Proportion of Trace Metals in John F. Baldwin Ship Channel Sediments Relative to Concentration Found in Point Reyes Fine Sediment (N/A=not applicable)

Station, Section (ft)		Ag	Al	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
West Richmond														
WR VII C	0-5.5	1.8	N/A	1.3	0.3	N/A	0.6	2.1	2.3	1.3	2.2	1.9	N/A	1.3
WR VI L	0-4	2.8	N/A	1.6	0.3	N/A	0.6	2.3	3.8	1.4	1.8	N/A	1.4	1.5
WR V L	0-6	6.0	N/A	1.6	0.5	N/A	0.6	3.4	3.6	1.7	3.7	N/A	N/A	2.1
WR IV.5 C	0-4	5.5	N/A	1.5	0.4	N/A	0.7	3.4	4.1	1.8	3.5	N/A	N/A	2.0
WR IV.5 C	4-8	1.0	N/A	2.0	0.3	N/A	0.5	2.0	1.0	1.7	1.0	N/A	N/A	1.3
WR IV R	0-6	9.6	N/A	1 7	0.5	N/A	0.7	3.9	5.5	2.0	4.3	N/A	1.4	2.3
WR IV R	6-11.5	2.3	N/A	1.6	0.2	N/A	0.7	2.1	1.6	1.9	1.4	N/A	1.4	1.4
WR IV R	6-11.5	2.0	N/A	1.4	0.2	N/A	0.6	2.0	0.7	1.9	1.3	N/A	1.4	1.4
WR III L	0-6.6	1.3	N/A	1.2	0.2	N/A	0.5	1.9	0.3	1.9	1.0	N/A	1.8	1.3
WR III C	0-6.4	1.0	N/A	1.4	0.2	N/A	0.6	2.0	0.3	1.8	1.0	N/A	1.4	1.3
WR II L	0-6.9	1.0	N/A	1.2	0.2	N/A	0.6	1.8	3.6	1.8	0.7	N/A	1.8	1.3
WR I R	0-5.1	4.8	N/A	1.3	0.4	N/A	1.1	3.1	2.9	1.9	3.2	N/A	1.4	1.9
Pinole Shoal														
P I C	0-3	2.0	N/A	1.5	0.3	N/A	0.6	3.2	0.9	2.1	1.3	N/A	1.4	1.7
P II C	0-4.3	2.3	N/A	1.6	0.3	N/A	0.5	3.7	0.7	2.1	1.1	N/A	1.8	1.9
P III L	0-3	2.3	N/A	1.3	0.3	N/A	0.6	3.8	0.9	2.2	1.2	2.6	1.4	1.8
P IV R	0-8	2.0	N/A	1.2	0.3	N/A	0.7	2.7	0.9	2.0	1.2	N/A	2.3	1.6
P V L	0-8.4	4.0	N/A	1.4	0.4	N/A	0.7	4.6	2.3	2.3	2.3	N/A	1.8	2.1
P V C	0-8.7	2.3	N/A	1.2	0.3	N/A	0.6	4.0	0.9	2.4	1.6	N/A	1.4	1.8
P V R	0-5	3.0	N/A	1.8	0.4	N/A	0.7	4.8	2.6	2.4	1.7	N/A	1.8	2.1
P V R	5-10.5	2.5	N/A	1.4	0.3	N/A	0.7	3.5	0.9	2.2	1.1	1.8	1.4	1.8
P VI L	0-5	6.8	N/A	2.4	0.8	N/A	0.8	6.3	5.5	2.9	3.8	N/A	1.8	2.9
P VI L	5-11.6	2.5	N/A	1.2	0.3	N/A	0.6	3.9	0.9	2.3	1.3	N/A	1.8	1.8
P VI C	0-9	2.0	N/A	1.2	0.2	N/A	0.7	2.5	0.3	2.1	1.4	N/A	2.3	1.5
P VI R	0-5	3.8	N/A	1.4	0.3	N/A	0.8	3.6	2.0	2.3	2.4	N/A	1.8	2.1
P VI R	5-11.7	2.0	N/A	1.3	0.3	N/A	0.7	3.6	0.7	2.2	1.0	N/A	2.3	1.8

Table C.6. (Continued)

Station, Section (ft)		Ag	Al	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Pinole Shoal, cont'd														
P VII C	0-5	3.0	N/A	1.7	0.4	N/A	0.8	3.9	2.3	2.2	2.1	N/A	1.8	1.9
P VII C	5-10.1	1.8	N/A	1.3	0.2	N/A	0.6	3.0	0.4	2.1	1.1	N/A	1.4	1.6
P VIII L	0-5.6	6.0	N/A	1.9	0.5	N/A	0.6	5.3	3.5	2.5	3.5	N/A	2.3	2.5
P VIII L	6.6-9.5	1.0	N/A	1.2	0.1	N/A	0.8	2.1	0.4	1.9	1.2	N/A	1.4	1.3
P VIII R	0-8	4.5	N/A	2.0	0.5	N/A	0.8	4.9	2.8	2.6	2.5	N/A	1.8	2.4
P VIII R	8-10.5	1.5	N/A	2.6	0.2	N/A	0.7	2.5	0.4	1.9	1.1	N/A	1.4	1.4
P VIII.5 C	0-3.6	1.3	N/A	1.7	0.2	N/A	0.7	2.0	0.6	2.0	1.8	N/A	0.9	1.4
P VIII.5 C	3.6-10.4	1.3	N/A	1.2	0.2	N/A	0.7	3.1	0.6	2.2	0.9	N/A	1.4	1.5
P VIII.5 C	3.6-10.4	1.5	N/A	1.2	0.2	N/A	0.9	2.5	0.4	2.0	1.2	N/A	1.8	1.5
P IX C	0-5	1.3	N/A	1.7	0.1	N/A	0.8	2.0	0.3	1.9	1.1	N/A	1.8	1.4
P IX C	5-11.8	1.0	N/A	1.6	0.1	N/A	0.8	1.9	0.3	2.0	1.0	N/A	0.9	1.3
P IX.5 L	0-5	1.5	N/A	1.2	0.2	N/A	1.0	2.1	0.7	2.0	1.8	N/A	0.9	1.4
P IX.5 L	0-5	1.3	N/A	1.5	0.2	N/A	0.8	1.8	0.9	1.8	1.8	N/A	1.4	1.3
P IX.5 L	5-10.1	1.0	N/A	1.1	0.1	N/A	0.8	1.8	0.3	2.1	1.3	N/A	1.8	1.2
P X R	0-6	1.3	N/A	1.3	0.2	N/A	0.9	2.0	0.7	2.1	1.5	N/A	1.8	1.5
P X R	6-11.5	1.0	N/A	1.8	0.1	N/A	1.2	2.1	0.3	2.2	1.1	N/A	0.9	1.3
P X.5 C	0-5	1.8	N/A	1.7	0.1	N/A	0.9	1.9	0.4	1.9	1.2	N/A	1.6	1.4
P X.5 C	5-11	1.0	N/A	1.4	0.1	N/A	1.0	2.4	0.4	1.9	1.0	N/A	0.9	1.3
P XI L	0-3.5	3.5	N/A	1.4	0.3	N/A	1.0	3.2	1.4	2.2	1.4	N/A	1.4	1.7
P XII R	0-8.5	1.3	N/A	2.0	0.2	N/A	1.0	3.8	3.8	2.1	1.6	N/A	2.3	1.6
P XII RR	0-9.2	3.0	N/A	1.9	0.3	N/A	0.8	4.5	3.5	2.2	1.8	N/A	0.9	2.1
P XII B2	0-2	1.0	N/A	1.2	0.2	N/A	0.9	1.7	0.9	1.8	2.2	N/A	0.9	1.5
P XII B2	2-7.5	2.0	N/A	2.3	0.3	N/A	0.8	5.0	4.5	2.1	2.0	N/A	1.8	1.6
P XII B2	2-7.5	3.5	N/A	2.4	0.2	N/A	0.8	4.5	4.8	2.1	1.8	2.7	1.4	1.6
P XII B2	7.5-12.5	2.0	N/A	1.1	0.2	N/A	1.6	3.1	0.9	2.2	1.0	N/A	1.8	1.7
P XII B1	0-5	5.8	N/A	1.9	0.7	N/A	0.7	6.1	3.5	2.4	3.2	N/A	1.8	2.7
P XII B1	5-11.1	---	N/A	1.7	0.4	N/A	1.1	4.2	1.9	2.2	1.7	3.0	0.9	2.0
P XII.5 C	0-6	2.0	N/A	2.4	0.4	N/A	0.7	4.6	5.7	1.9	2.3	N/A	1.4	1.8
P XII.5 C	0-6	1.8	N/A	2.3	0.2	N/A	0.7	4.2	4.9	2.0	2.1	N/A	1.4	1.7

Table C.6. (Continued)

Station, Section (ft)		Ag	Al	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Pinole Shoal, cont'd														
P XII.5 R	0-5.3	2.0	N/A	2.0	0.2	N/A	0.7	4.9	4.8	2.1	2.1	0.42	1.8	1.7
P XII.5 R	5.3-11.1	1.8	N/A	1.3	0.2	N/A	1.3	3.2	0.7	2.1	1.0	N/A	1.8	1.7
P XIII L	0-6	2.3	N/A	2.4	0.3	N/A	0.5	4.3	4.3	1.7	2.1	1.7	1.8	1.6
P XIII L	0-6	2.3	N/A	2.3	0.3	N/A	0.6	4.4	4.2	1.6	2.2	N/A	1.8	1.7
P XIII R	0-5	2.0	N/A	2.4	0.3	N/A	0.6	4.3	4.2	1.5	1.8	N/A	1.8	1.6
P XIII R	5-10	2.0	N/A	2.6	0.3	N/A	0.6	4.5	5.4	1.9	1.6	N/A	2.3	1.6
P XIV C	0-4.5	6.5	N/A	2.4	0.7	N/A	0.8	4.5	4.3	2.0	8.3	N/A	0.9	2.5
Carquinez Strait														
CB 1	0-6.6	3.5	N/A	2.6	0.4	N/A	0.7	4.9	5.9	1.8	3.3	N/A	2.3	1.8
C I R	0-8	9.5	N/A	2.5	0.4	N/A	0.5	4.7	5.2	1.8	2.7	N/A	2.3	1.9
C I R	0-8	3.3	N/A	2.7	0.3	N/A	0.5	4.5	5.8	1.7	3.1	N/A	1.8	1.8
CB 4 A	0-3.8	4.0	N/A	2.5	0.4	N/A	0.8	4.6	3.9	2.0	2.9	2.5	1.4	2.3
CB 4 A	3.8-11.4	2.3	N/A	2.6	0.2	N/A	0.7	5.5	5.5	2.3	2.0	N/A	1.8	1.8
CB 5	0-4	1.3	N/A	1.4	0.2	N/A	0.6	2.4	1.9	1.8	2.0	N/A	N/A	1.6
CB 6	0-6.5	5.5	N/A	2.0	0.9	N/A	0.7	5.4	6.4	2.1	4.6	N/A	N/A	2.7
CB 7	0-3.1	6.8	N/A	2.0	0.6	N/A	0.6	5.0	3.2	2.1	3.3	2.8	1.8	2.4
C II C	0-4	0.3	N/A	1.2	0.1	N/A	0.6	1.4	0.9	1.6	1.4	N/A	N/A	1.3
C II C	4-6.8	1.6	N/A	2.3	0.5	N/A	0.7	2.7	2.6	1.9	2.3	N/A	N/A	1.9
C II R	0-2.4	1.5	N/A	3.0	0.3	N/A	0.5	4.4	6.5	1.6	1.8	N/A	N/A	1.5

Table C.7. Butyltins (μg/kg) in John F. Baldwin Ship Channel Sediments (<=not detected above given detection limit; N/A=not applicable)

Station, section (ft)		Propyl Tin Recovery (%)	Butyltin Species Tetra	Tri	Di	Mono	Total
Detection Limits							
Target DL		N/A	10	10	10	10	N/A
Lowest Achieved DL		N/A	0.41	0.40	0.41	0.42	N/A
Maximum Achieved DL		N/A	2.2	0.80	0.83	2.3	N/A
West Richmond							
WR VII C	0-5.5	36	<0.54	1.8	15	1.2	18
WR VI L	0-4	56	<0.63	0.82	7.1	1.6	9.5
WR V L	0-6	43	<2.2	7.3	12	<2.3	19.3
WR IV.5 C	0-4	48	<0.74	<0.74	2.1	<0.76	2.1
WR IV.5 C	4-8	36	<0.61	<0.62	0.74	<0.63	0.74
WR IV R	0-6	82	<1.9	2.3	5.1	<2.0	7.4
WR IV R	6-11.5 rep 1	45	<0.55	0.81	<0.55	<0.56	0.81
WR IV R	6-11.5 rep 2	63	<0.44	0.49	0.97	<0.46	1.46
WR III L	0-6.6	45	<0.54	0.53	<0.55	<0.56	0.53
WR III C	0-6.4	45	<0.55	<0.56	0.71	<0.57	0.71
WR II L	0-6.9	51	<0.48	<0.49	<0.50	<0.50	N/A
WR I R	0-5.1	45	<1.6	2.1	7.9	3.0	13.0
Pinole Shoal							
P I C	0-3	54	<0.71	0.83	<0.72	<0.73	0.83
P II C	0-4.3	31	<0.70	1.0	3.5	1.1	5.6
P III L	0-3	38	<0.65	0.74	0.68	<0.69	1.42
P IV R	0-8	68	<0.59	0.96	1.3	1.0	3.3
P V L	0-8.4	39	<0.67	0.93	1.7	0.83	3.5
P V C	0-8.7	57	<0.81	<0.80	<0.83	<0.84	N/A
P V R	0-5	63	<0.64	<0.63	0.66	<0.41	0.66
P V R	5-10.5	58	<0.68	<0.66	<0.68	<0.70	N/A
P VI L	0-5	55	<0.66	0.71	<0.67	<0.68	0.71
P VI L	5-11.6	42	0.62	0.63	3.2	<0.66	4.5
P VI C	0-9	49	<0.56	0.81	1.7	0.81	3.3
P VI R	0-5	53	<0.59	1.6	1.2	0.69	3.5
P VI R	5-11.7	97	<0.68	2.7	4.5	1.5	8.7
P VII C	0-5	39	<0.62	0.63	2.5	0.68	3.8
P VII C	5-10.1	83	<0.63	2.6	6.5	0.97	10.1
P VIII L	0-6.6	68	<0.70	4.0	0.71	2.4	7.1
P VIII L	6.6-9.5	53	<0.41	<0.40	<0.41	<0.42	N/A
P VIII R	0-8	70	<0.74	3.9	2.1	1.9	7.9
P VIII R	8-10.5	52	<0.55	<0.54	1.5	0.57	1.5

Table C.7. (Continued)

Station, section (ft)	Propyl Tin Recovery (%)	Butyltin Species				
		Tetra	Tri	Di	Mono	Total
Pinole Shoal cont'd						
P VIII.5 C 0-3.6	46	<0.46	2.1	0.74	<0.47	2.8
P VIII.5 C 3.6-10.4 rep 1	58	<0.50	<0.49	0.57	<0.52	0.57
P VIII.5 C 3.6-10.4 rep 2	54	<0.60	<0.59	1.1	<0.62	1.1
P IX C 0-5	47	<0.51	<0.50	<0.51	<0.52	N/A
P IX C 5-11.8	48	<0.46	<0.46	<0.47	<0.48	N/A
P IX.5 L 0-5 rep 1	53	<0.48	<0.48	<0.48	<0.49	N/A
P IX.5 L 0-5 rep 2	71	<0.45	0.55	0.56	0.47	1.58
P IX.5 L 5-10.1	63	<0.47	0.58	0.72	<0.49	1.3
P X R 0-6	80	<0.54	2.0	2.8	1.2	6.0
P X R 6-11.5	42	<0.47	0.48	<0.47	<0.48	0.48
P X.5 C 0-5	43	<0.48	0.53	0.57	<0.50	1.10
P X.5 C 5-11	43	<0.47	0.48	<0.47	<0.48	0.48
P XI L 0-3.5	63	<0.58	<0.59	<0.58	<0.60	N/A
P XII R 0-8.5	31	<0.62	<0.62	<0.62	<0.64	N/A
P XII RR 0-9.2	125	<0.69	3.7	1.7	1.3	6.7
P XII B2 0-2	46	<0.86	1.5	1.3	<0.92	2.8
P XII B2 2-7.5 rep 1	45	<0.51	0.89	1.0	2.0	3.9
P XII B2 2-7.5 rep 2	79	<1.6	2.7	11	3.1	17.0
P XII B2 7.5-12.5	69	<0.48	0.75	3.1	0.95	4.8
P XII B1 0-5	66	<0.73	2.1	5.0	2.4	9.5
P XII B1 5-11.1	46	<0.56	0.89	3.1	<0.58	4.0
P XII.5 C 0-6 rep 1	42	<0.62	0.67	1.4	0.88	2.9
P XII.5 C 0-6 rep 2	60	<0.78	0.87	<0.77	<0.59	0.87
P XII.5 R 0-5.3	22	<0.71	2.5	0.88	0.78	4.2
P XII.5 R 5.3-11.1	92	<0.67	3.0	<0.69	1.0	4.0
P XIII L 0-6 rep 1	36	<0.87	3.1	6.5	1.5	11.1
P XIII L 0-6 rep 2	43	<0.57	<0.57	1.3	0.74	2.0
P XIII R 0-5	72	<0.62	2.1	1.9	<0.67	4.0
P XIII R 5-10	45	<0.57	1.5	1.2	0.66	3.4
P XIV C 0-4.5	45	<0.59	<0.59	0.59	0.71	1.30
Carquinez Strait						
CB 1 0-6.6	81	<0.70	2.5	2.1	1.3	5.9
C I R 0-8 rep 1	41	<0.60	1.7	2.6	0.74	5.0
C I R 0-8 rep 2	64	<0.81	2.9	1.8	1.1	5.8
CB 4 A 0-3.8	37	<1.8	6.1	12	3.3	21
CB 4 A 3.8-11.4	37	<0.53	0.57	1.5	<0.55	2.1
CB 5 0-4	42	<0.55	0.57	1.4	<0.56	2.0
CB 6 0-6.5	86	<0.69	2.8	3.5	1.1	7.4
CB 7 0-3.1	33	<0.99	29	3.5	4.1	37
C II C 0-4	39	<0.51	<0.51	1.3	<0.52	1.3
C II C 4-6.8	40	<0.60	<0.61	5.8	1.0	6.8
C II R 0-2.4	40	<0.65	1.2	1.3	0.97	3.5

Table C.8. Semivolatile Organic Compounds (PAH) (μg/kg), Total PAH, and High Molecular Weight PAH (HPAH) Fraction in John F. Baldwin Ship Channel Sediments (<=compound was undetected at given detection limit; N/A=not applicable)

Station, Section (ft)		Acenaph-thene	Acenaph-thylene	Anthra-cene	Benzo(a) Anthra-cene	Benzo(a) pyrene	Benzo(b) flouran-thene	Benzo(k) fluoran-thene	Benzo (g,h,i) perylene	Chrysene
Detection Limits										
Target DL		20	20	20	20	20	20	20	20	20
Lowest Achieved DL		3.1	3.1	3.4	2.2	2.7	3.1	4.1	5.6	2.7
Maximum Achieved DL		6.9	6.9	7.7	4.9	5.8	6.5	9.3	13.0	5.8
West Richmond										
WR VII C	0-5.5	17.0	25.0	110.0	300.0	370.0	210.0	230.0	220.0	320.0
WR VI L	0-4	26.0	15.0	87.0	150.0	310.0	160.0	190.0	170.0	160.0
WR V L	0-6	38.0	21.0	100.0	180.0	270.0	160.0	170.0	120.0	190.0
WR IV.5 C	0-4	<6.9	21.0	58.0	97.0	170.0	120.0	120.0	110.0	120.0
WR IV.5 C	4-8	<4.9	<4.9	<5.5	<3.5	<4.4	<4.9	<6.7	<9.0	<4.4
WR IV R	0-6	<5.2	<5.2	69.0	110.0	220.0	150.0	140.0	150.0	130.0
WR IV R	6-11.5(a)	<6.1	<6.1	31.5	44.5	40.0	18.5	32.0	17.0	37.5
WR III L	0-6.6	<3.8	<3.8	<4.3	<2.7	<3.4	<3.8	<5.2	<7.0	<3.4
WR III C	0-6.4	<6.5	<6.5	<7.3	<4.6	<5.8	<6.5	<8.8	<12.0	<5.8
WR II L	0-6.9	<4.7	<4.7	<5.3	<3.3	<4.2	<4.7	<6.4	<8.6	<4.2
WR I R	0-5.1	<5.6	<5.6	23.0	56.0	130.0	65.0	72.0	110.0	61.0
Pinole Shoal										
P I C	0-3	<5.6	<5.6	<6.3	<3.9	<4.9	<5.6	<7.6	<10.0	<4.9
P II C	0-4.3	<5.2	<5.2	<5.8	<3.7	<4.6	<5.2	<7.0	<9.5	<4.6
P III L	0-3	<5.9	<5.9	<6.6	<4.2	<5.2	<5.9	<8.0	<11.0	<5.2
P IV R	0-8	<5.2	<5.2	<5.8	<3.6	<4.5	<5.2	<7.0	<9.4	<4.5
P V L	0-8.4	<5.1	<5.1	<5.7	<3.6	<4.5	<5.1	<6.9	<9.3	<4.5
P V C	0-8.7	<4.5	<4.5	<5.0	<3.2	<3.9	<4.5	<6.1	<8.2	<3.9
P V R	0-5	<4.7	<4.7	<5.2	<3.3	<4.1	<4.7	<6.4	<8.6	<4.1

Table C.8. (Continued)

Station, Section (ft)		Acenaph-thene	Acenaph-thylene	Anthra-cene	Benzo(a) Anthra-cene	Benzo(a) pyrene	Benzo(b) flouran-thene	Benzo(k) fluoran-thene	Benzo (g,h,i) perylene	Chrysene
Pinole Shoal, cont'd										
P V R	5-10.5	<4.8	<4.8	<5.3	<3.4	<4.2	<4.8	<6.5	<8.7	<4.2
P VI L	0-5	<6.9	<6.9	<7.7	<4.9	19.0	18.0	<9.3	<13.0	27.0
P VI L	5-11.6	<4.1	<4.1	<4.6	<2.9	<3.7	<4.1	<5.6	<7.6	<3.7
P VI C	0-9	<3.5	<3.5	<4.0	<2.5	<3.1	<3.5	<4.8	<6.5	<3.1
P VI R	0-5	<5.6	<5.6	<6.2	<3.9	<4.9	<5.6	<7.5	<10.0	<4.9
P VI R	5-11 7	<4.3	<4.3	<4.8	<3.1	<3.8	<4.3	<5.9	<7.9	<3.8
P VII C	0-5	<4.6	<4.6	<5.2	<3.3	<4.1	<4.6	<6.3	<8.5	<4.1
P VII C	5-10.1	<5.6	<5.6	<6.2	<3.9	<4.9	<5.6	<7.5	<10.0	<4.9
P VIII L	0-6.6	<5.2	<5.2	<5.8	<3.7	<4.6	<5.2	<7.0	<9.5	13.0
P VIII L	6.6-9.5	<3.3	<3.3	<3.7	<2.3	<2.9	<3.3	<4.5	<6.0	<2.9
P VIII R	0-8	<5.5	<5.5	<6.2	<3.9	<4.9	<5.5	<7.5	<10.0	<4.9
P VIII R	8-10.5	<4.1	<4.1	<4.6	<2.9	<3.6	<4.1	<5.5	<7.5	<3.6
P VIII.5 C	0-3.6	<4.1	<4.1	<4.6	<2.9	<3.6	<4.1	<5.6	<7.5	<3.6
P VIII.5 C	3.6-10.4(a)	<4.2	<4.2	<4.7	<2.9	<3.7	<4.2	<5.6	<7.6	<3.7
P IX C	0-5	<3.6	<3.6	<4.1	<2.6	<3.2	<3.6	<4.9	<6.6	<3.2
P IX C	5-11.8	<4.0	<4.0	<4.4	<2.8	<3.5	<4.0	<5.3	<7.2	<3.5
P IX.5 L	0-5(a)	<3.7	<3.7	<4.1	<2.6	<3.2	<3.7	<5.0	<6.7	<3.2
P IX.5 L	5-10.1	<3.4	<3.4	<3.8	<2.4	<3.0	<3.4	<4.6	<6.2	<3.0
P X R	0-6	<3.0	<3.0	<3.4	<2.1	<2.7	<3.0	<4.1	<5.5	<2.7
P X R	6-11.5	<3.2	<3.2	<3.6	<2.3	<2.8	<3.2	<4.4	<5.9	<2.8
P X.5 C	0-5	<4.7	<4.7	<5 3	<3.3	<4.2	<4.7	<6.4	<8.6	<4.2
P X.5 C	5-11	<3.1	<3.1	<3.4	<2.2	<2.7	<3.1	<4.1	<5.6	<2.7
P XI L	0-3.5	<5.3	<5.3	<5.9	<3.7	<4.7	<5.3	<7.1	<9.6	<4.7
P XII R	0-8.5	<6.2	<6.2	<6.9	<4.4	<5.5	<6.2	<8.4	<11.0	<5.5
P XII RR	0-9.2	<4.4	<4.4	<4.9	<3.1	<3.9	<4.4	<6.0	<8.0	<3.9
P XII B2	0-2	<3.3	<3.3	<3.7	<2.3	<2.9	<3.3	<4.5	<6.0	<2.9
P XII B2	2-7.5(a)	<5.7	<5.7	<6.4	<4.0	<5.0	<5.7	<7.7	<10.0	<5.0
P XII B2	7.5-12.5	<4.5	<4.5	<5.0	<3.2	<4.0	<4.5	<6.1	<8.2	<4.0

Table C.8. (Continued)

Station, Section (ft)		Acenaph-thene	Acenaph-thylene	Anthra-cene	Benzo(a) Anthra-cene	Benzo(a) pyrene	Benzo(b) flouran-thene	Benzo(k) fluoran-thene	Benzo (g,h,i) perylene	Chrysene
Pinole Shoal, cont'd										
P XII B1	0-5	<6.2	<6.2	<6.9	<4.3	<5.4	<6.2	<8.3	<11.0	<5.4
P XII B1	5-11.1	<4.6	<4.6	<5.2	<3.3	<4.1	<4.6	<6.3	<8.5	<4.1
P XII.5 C	0-6(a)	<5.5	<5.5	<6.2	<3.9	<4.9	<5.5	<7.5	<10.0	<4.9
P XII.5 R	0-5.3	<5.1	<5.1	<5.7	<3.6	<4.5	<5.1	<6.9	<9.3	<4.5
P XII.5 R	5.3-11.1	<5.5	<5.5	<6.1	<3.9	<4.8	<5.5	<7.4	<10.0	<4.8
P XIII L	0-6(a)	<4.9	<4.9	<5.5	<3.5	<4.4	<4.9	<6.7	<9.0	<4.4
P XIII R	0-5	<5.9	<5.9	<6.6	<4.2	<5.2	<5.9	<8.0	<11.0	<5.2
P XIII R	5-10	<4.4	<4.4	<4.9	<3.1	<3.8	<4.4	<5.9	<7.9	<3.8
P XIV C	0-4.5	<6.1	<6.1	<6.8	14.0	26.0	21.0	<8.2	17.0	21.0
Carquinez Strait										
CB 1	0-6.6	<5.4	<5.4	<6.1	<3.8	<4.8	<5.4	<7.4	<9.9	<4.8
C I R	0-8(a)	<5.3	<5.3	<5.9	<3.7	<4.7	<5.3	<7.1	<9.6	<4.7
CB 4 A	0-3.8	<5.9	<5.9	<6.6	32.0	33.0	39.0	30.0	<11.0	42.0
CB 4 A	3.8-11.4	<5.0	<5.0	<5.6	<3.5	<4.4	<5.0	<6.7	<9.1	<4.4
CB 5	0-4	<3.8	<3.8	<4.3	<2.7	<3.4	<3.8	<5.2	<7.0	<3.4
CB 6	0-6.5	<4.3	<4.3	<4.8	11.0	15.0	15.0	10.0	13.0	19.0
CB 7	0-3.1	<4.8	<4.8	<5.3	19.0	24.0	24.0	16.0	27.0	26.0
C II C	0-4	<5.5	<5.5	<6.1	<3.9	<4.8	<5.5	<7.4	<10.0	<4.8
C II C	4-6.8	<4.5	<4.5	<5.1	<3.2	<4.0	<4.5	<6.2	<8.3	<4.0
C II R	0-2.4	<4.7	<4.7	<5.2	<3.3	<4.1	<4.7	<6.3	<8.5	<4.1

Table C.8. (Continued)

Station, Section (ft)		Dibenzo (a,h) anthracene	Fluoran-thene	Fluorene	Indeno-(1,2,3-c,d) pyrene	Naphtha-lene	Phenan-threne	Pyrene	Total PAH	Total HPAH	% HPAH
Detection Limits											
Target DL		20	20	20	20	20	20	20	N/A	N/A	N/A
Lowest Achieved DL		3.4	5.6	3.1	4.5	2.9	3.6	6.8	N/A	N/A	N/A
Maximum Achieved DL		7.7	12.0	6.9	10.0	6.5	6.9	15.0	N/A	N/A	N/A
West Richmond											
WR VII C	0-5.5	27.0	370.0	28.0	170.0	21.0	360.0	760.0	3538	2977	84
WR VI L	0-4	<6.9	430.0	16.0	96.0	<5.8	340.0	590.0	2740	2256	82
WR V L	0-6	<6.9	420.0	23.0	86.0	17.0	510.0	770.0	3075	2356	77
WR IV.5 C	0-4	<7.7	240.0	17.0	60.0	<6.5	270.0	380.0	1783	1417	79
WR IV.5 C	4-8	<5.5	<9.0	<4.9	<7.3	<4.7	<5.8	<11.0	0	0	N/A
WR IV R	0-6	<5.9	170.0	<5.2	100.0	20.0	160.0	410.0	1829	1580	86
WR IV R	6-11.5(a)	<5.8	76.0	<6.1	<6.9	<5.7	76.0	100.5	474	366	77
WR III L	0-6.6	<4.3	<7.0	<3.8	<5.6	<3.6	<4.5	<8.5	0	0	N/A
WR III C	0-6.4	<7.3	<12.0	<6.5	<9.6	<6.2	<7.7	<15.0	0	0	N/A
WR II L	0-6.9	<5.3	<8.6	<4.7	<6.9	<4.4	<5.6	<11.0	0	0	N/A
WR I R	0-5.1	<6.2	90.0	<5.6	62.0	<5.2	79.0	130.0	678	776	88
Pinole Shoal											
P I C	0-3	<6.3	<10.0	<5.6	<8.2	<5.3	<6.6	<13.0	0	0	N/A
P II C	0-4.3	<5.8	<9.5	<5.2	<7.6	<4.9	<6.1	<12.0	0	0	N/A
P III L	0-3	<6.6	<11.0	<5.9	<8.7	<5.6	<6.9	<13.0	0	0	N/A
P IV R	0-8	<5.8	<9.4	<5.2	<7.6	<4.8	<6.1	<12.0	0	0	N/A
P V L	0-8.4	<5.7	<9.3	<5.1	<7.5	<4.8	<6.0	<11.0	0	0	N/A
P V C	0-8.7	<5.0	<8.2	<4.5	<6.6	<4.2	<5.3	<10.0	0	0	N/A
P V R	0-5	<5.2	<8.6	<4.7	<6.9	<4.4	<5.5	17.0	17	17	100
P V R	5-10.5	<5.3	<8.7	<4.8	<7.0	<4.5	<5.6	<11.0	0	0	N/A

Table C.8. (Continued)

Station, Section (ft)		Dibenzo (a,h) anthracene	Fluoran-thene	Fluorene	Indeno-(1,2,3-c,d) pyrene	Naphtha-lene	Phenan-threne	Pyrene	Total PAH	Total HPAH	% HPAH
Pinole Shoal, cont'd											
P VI L	0-5	<7.7	23.0	<6.9	<10.0	<6.5	18.0	61.0	166	148	89
P VI L	5-11.6	<4.6	<7.5	<4.1	<6.1	<3.9	<4.9	<9.3	0	0	N/A
P VI C	0-9	<4.0	<6.5	<3.5	<5.2	<3.3	<4.2	<7.9	0	0	N/A
P VI R	0-5	<6.2	<10.0	<5.6	<8.2	<5.2	<6.5	<12.0	0	0	N/A
P VI R	5-11.7	<4.8	<7.9	<4.3	<6.4	<4.1	<5.1	<9.7	0	0	N/A
P VII C	0-5	<5.2	11.0	<4.6	<6.8	<4.4	<5.5	<10.0	11	11	100
P VII C	5-10.1	<6.2	<10.0	<5.6	<8.2	<5.2	<6.5	<12.0	0	0	N/A
P VIII L	0-6.6	<5.8	15.0	<5.2	<7.6	<4.9	<6.1	27.0	55	55	100
P VIII L	6.6-9.5	<3.7	<6.0	<3.3	<4.9	<3.1	<3.9	<7.4	0	0	N/A
P VIII R	0-8	<6.2	<10.0	<5.5	<8.1	<5.2	<6.5	18.0	18	18	100
P VIII R	8-10.5	<4.6	<7.5	<4.1	<6.0	<3.8	<4.8	<9.1	0	0	N/A
P VIII.5 C	0-3.6	<4.6	<7.5	<4.1	<6.1	<3.9	<4.9	<9.2	0	0	N/A
P VIII.5 C	3.6-10.4(a)	<4.7	<7.5	<4.2	<6.1	<3.9	<4.9	<9.3	0	0	N/A
P IX C	0-5	<4.1	<6.6	<3.6	<5.3	<3.4	<4.3	<8.1	0	0	N/A
P IX C	5-11.8	<4.4	<7.2	<4.0	<5.8	<3.7	<4.7	<8.8	0	0	N/A
P IX.5 L	0-5(a)	<4.1	<6.7	<3.7	<5.4	<3.4	<4.3	<8.2	0	0	N/A
P IX.5 L	5-10.1	<3.8	<6.2	<3.4	<5.0	<3.2	<4.0	<7.6	0	0	N/A
P X R	0-6	<3.4	<5.5	<3.0	<4.4	<2.8	<3.5	<6.7	0	0	N/A
P X R	6-11.5	<3.6	<5.9	<3.2	<4.7	<3.0	<3.8	<7.2	0	0	N/A
P X.5 C	0-5	<5.3	<8.6	<4.7	<6.9	<4.4	<5.6	<11.0	0	0	N/A
P X.5 C	5-11	<3.4	<5.6	<3.1	<4.5	<2.9	<3.6	<6.8	0	0	N/A
P XI L	0-3.5	<5.9	<9.6	<5.3	<7.8	<5.0	<6.2	<12.0	0	0	N/A
P XII R	0-8.5	<6.9	<11.0	<6.2	<9.1	<5.8	<7.3	<14.0	0	0	N/A
P XII RR	0-9.2	<4.9	<8.0	<4.4	<6.5	<4.1	<5.2	<9.8	0	0	N/A
P XII B2	0-2	<3.7	<6.0	<3.3	<4.9	<3.1	<3.9	<7.4	0	0	N/A
P XII B2	2-7.5(a)	<6.4	<10.0	<5.7	<8.4	<5.4	<6.7	<13.0	0	0	N/A
P XII B2	7.5-12.5	<5.0	<8.2	<4.5	<6.6	<4.2	<5.3	<10.0	0	0	N/A

Table C.8. (Continued)

Station, Section (ft)		Dibenzo (a,h) anthracene	Fluoran-thene	Fluorene	Indeno-(1,2,3-c,d) pyrene	Naphtha-lene	Phenan-threne	Pyrene	Total PAH	Total HPAH	% HPAH
Pinole Shoal, cont'd											
P XII B1	0-5	<6.9	24.6	<6.2	<9.1	<5.8	17.0	25.0	66	49	74
P XII B1	5-11.1	<5.2	<8.5	<4.6	<6.8	<4.4	<5.5	<10.0	0	0	N/A
P XII.5 C	0-6(a)	<6.2	<10.0	<5.5	<8.1	<5.2	<6.5	<12.0	0	0	N/A
P XII.5 R	0-5.3	<5.7	<9.3	<5.1	<7.5	<4.8	<6.0	<11.0	0	0	N/A
P XII.5 R	5.3-11.1	<6.1	<10.0	<5.5	<8.1	<5.2	<6.5	<12.0	0	0	N/A
P XIII L	0-6(a)	<5.5	11.0	<4.9	<7.3	<4.7	<5.6	15.0	26	26	100
P XIII R	0-5	<6.6	<11.0	<5.9	<8.7	<5.6	<6.9	<13.0	0	0	N/A
P XIII R	5-10	<4.9	<7.9	<4.4	<6.4	<4.1	<5.1	<9.7	0	0	N/A
P XIV C	0-4.5	<6.8	23.0	<6.1	<8.9	<5.7	<7.1	57.0	179	179	100
Carquinez Strait											
CB 1	0-6.6	<6.1	<9.9	<5.4	<8.0	<5.1	<6.4	<12.0	0	0	N/A
C I R	0-8(a)	<5.9	<9.6	<5.3	<7.8	<5.0	<6.2	<12.0	0	0	N/A
CB 4 A	0-3.8	<6.6	72.0	<5.9	<8.6	<5.5	34.0	116.0	392	358	91
CB 4 A	3.8-11.4	<5.6	<9.1	<5.0	<7.3	<4.7	<5.8	<11.0	0	0	N/A
CB 5	0-4	<4.3	<7.0	<3.8	<5.7	<3.6	<4.5	<8.6	0	0	N/A
CB 6	0-6.5	<4.8	16.0	<4.3	<6.4	<4.1	15.0	53.0	157	152	97
CB 7	0-3.1	<5.3	22.0	<4.8	16.0	<4.5	21.0	65.0	268	239	92
C II C	0-4	<6.1	<10.0	<5.5	<8.1	<5.2	<6.5	<12.0	0	0	N/A
C II C	4-6.8	<5.1	<8.3	<4.5	<6.7	<4.3	<5.3	26.0	26	26	100
C II R	0-2.4	<5.2	<8.5	<4.7	<5.9	<4.4	<5.5	<10.5	0	0	N/A

(a) Reported concentration is the average detected concentration of duplicate samples. If the compound was undetected in both samples, the higher detection limit is reported.

Table C.9. Chlorinated Pesticides and PCBs (μg/kg dry weight) in John F. Baldwin Ship Channel Sediments (<=not detected above given detection limit)

Station, Section (ft)		Aldrin	α-BHC	β-BHC	δ-BHC	Chlordane	4,4'-DDD	4,4'-DDE	4,4'-DDT	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan Sulfate
Detection Limit		1.0	8.0	4.0	8.0	10.0	3.0	3.0	3.0	3.0	10.0	20.0	10.0
West Richmond													
WR VII C	0-5.5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
WR VI L	0-4	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
WR V L	0-6	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
WR IV.5 C	0-4	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
WR IV.5 C	4-8	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
WR IV R	0-6	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
WR IV R	6-11.5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
WR IV R	6-11.5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
WR III L	0-6.6	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
WR III C	0-6.4	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
WR II L	0-6.9	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
WR I R	0-5.1	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
Pinole Shoal													
P I C	0-3	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P II C	0-4.3	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P III L	0-3	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P IV R	0-8	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P V L	0-8.4	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P V C	0-6.7	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P V R	0-5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P V R	5-10.5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VI L	0-5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VI L	5-11.6	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0

Table C.9. (Continued)

Station, Section (ft)		Aldrin	α-BHC	β-BHC	δ-BHC	Chlordane	4,4'-DDD	4,4'-DDE	4,4'-DDT	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan Sulfate
Detection Limit		1.0	8.0	4.0	8.0	10.0	3.0	3.0	3.0	3.0	10.0	20.0	10.0
Pinole Shoal, cont'd													
P VI C	0-9	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VI R	0-5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VI R	5-11.7	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VII C	0-5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VII C	5-10.1	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VIII L	0-6.6	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VIII L	6.6-9.5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VIII R	0-8	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VIII R	8-10.5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VIII.5 C	0-3.6	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VIII.5 C	3.6-10.4	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P VIII.5 C	3.6-10.4	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P IX C	0-5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P IX C	5-11.8	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P IX.5 L	0-5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P IX.5 L	0-5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P IX.5 L	5-10.1	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P X R	0-6	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P X R	6-11.5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P X.5 C	0-5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P X.5 C	5-11	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XI L	0-3.5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XII R	0-8.5	<1.0	<8.0	10	26	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XII RR	0-9.2	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XII B2	0-2	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XII B2	2-7.5	<1.0	<8.0	<4.0	31	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XII B2	2-7.5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XII B2	7.5-12.5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0

Table C.9. (Continued)

Station, Section (ft)		Aldrin	α-BHC	β-BHC	δ-BHC	Chlordane	4,4'-DDD	4,4'-DDE	4,4'-DDT	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan Sulfate
Detection Limit		1.0	8.0	4.0	8.0	10.0	3.0	3.0	3.0	3.0	10.0	20.0	10.0
Pinole Shoal, cont'd													
P XII B1	0-5	<1.0	<8.0	<4.0	29	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XII B1	5-11.1	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XII.5 C	0-6	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XII.5 C	0-6	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XII.5 R	0-5.3	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XII.5 R	5.3-11.1	<1.0	<8.0	<4.0	13	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XIII L	0-6	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XIII L	0-6	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XIII R	0-5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XIII R	5-10	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
P XIV C	0-4.5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
Carquinez Strait													
CB 1	0-6.6	<1.0	<8.0	<4.0	17	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
C I R	0-8	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
C I R	0-8	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
CB 4 A	0-3.8	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
CB 4 A	3.8-11.4	<1.0	<8.0	<4.0	19	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
CB 5	0-4	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
CB 6	0-6.5	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
CB 7	0-3.1	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
C II C	0-4	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
C II C	4-6.8	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0
C II R	0-2.4	<1.0	<8.0	<4.0	<8.0	<10.0	<3.0	<3.0	<3.0	<3.0	<10.0	<20.0	<10.0

Table C.9. (Continued)

Station, Section (ft)		Endrin	Endrin Aldehyde	Hepta-chlor	Heptachlor Epoxide	Lindane (γ-BHC)	Toxaphene	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
Detection Limit		10.0	2.0	0.8	3.0	1.0	10.0	50	50	50	50	50	50	50
West Richmond														
WR VII C	0-5.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
WR VI L	0-4	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
WR V L	0-6	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
WR IV.5 C	0-4	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
WR IV.5 C	4-8	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
WR IV R	0-6	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
WR IV R	6-11.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
WR IV R	6-11.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
WR III L	0-6.6	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
WR III C	0-6.4	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
WR II L	0-6.9	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
WR I R	0-5.1	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
Pinole Shoal														
P I C	0-3	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P II C	0-4.3	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P III L	0-3	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P IV R	0-8	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P V L	0-8.4	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P V C	0-8.7	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P V R	0-5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P V R	5-10.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VI L	0-5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VI L	5-11.6	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VI C	0-9	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50

Table C.9. (Continued)

Station, Section (ft)		Endrin	Endrin Aldehyde	Hepta-chlor	Heptachlor Epoxide	Lindane (γ-BHC)	Toxaphene	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
Detection Limit		10.0	2.0	0.8	3.0	1.0	10.0	50	50	50	50	50	50	50
Pinole Shoal, cont'd														
P VI R	0-5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VI R	5-11.7	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VII C	0-5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VII C	5-10.1	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VIII L	0-6.6	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VIII L	6.6-9.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VIII R	0-8	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VIII R	8-10.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VIII.5 C	0-3.6	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VIII.5 C	3.6-10.4	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P VIII.5 C	3.6-10.4	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P IX C	0-5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P IX C	5-11.8	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P IX.5 L	0-5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P IX.5 L	0-5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P IX.5 L	5-10.1	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P X R	0-6	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P X R	6-11.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P X.5 C	0-5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P X.5 C	5-11	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XI L	0-3.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XII R	0-8.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XII RR	0-9.2	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XII B2	0-2	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XII B2	2-7.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XII B2	2-7.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XII B2	7.5-12.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50

Table C.9. (Continued)

Station, Section (ft)		Endrin	Endrin Aldehyde	Hepta-chlor	Heptachlor Epoxide	Lindane (γ-BHC)	Toxaphene	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
Detection Limit		10.0	2.0	0.8	3.0	1.0	10.0	50	50	50	50	50	50	50
Pinole Shoal, cont'd														
P XII B1	0-5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XII B1	5-11.1	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XII.5 C	0-6	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XII.5 C	0-6	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XII.5 R	0-5.3	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XII.5 R	5.3-11.1	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XIII L	0-6	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XIII L	0-6	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XIII R	0-5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XIII R	5-10	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
P XIV C	0-4.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
Carquinez Strait														
CB 1	0-6.6	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
C I R	0-8	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
C I R	0-8	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
CB 4 A	0-3.8	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
CB 4 A	3.8-11.4	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
CB 5	0-4	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
CB 6	0-6.5	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
CB 7	0-3.1	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
C II C	0-4	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
C II C	4-8.8	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50
C II R	0-2.4	<10.0	<2.0	<0.8	<3.0	<1.0	<10.0	<50	<50	<50	<50	<50	<50	<50

APPENDIX D

QUALITY CONTROL DATA FOR CHEMICAL ANALYSES

Table D.1. Quality Control Data for TOC and Grain Size
(NA=data not available; N/A=not applicable)

Station, Section (ft)	TOC (% dry wt.)	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	Total Percent
Standard Reference Material						
SRM Mess-1	2.33	N/A	N/A	N/A	N/A	N/A
Compositing Duplicates						
WR IV R 6-11.5	0.28	1	67	17	15	100
WR IV R 6-11.5	0.62	1	66	17	16	100
P VIII.5 C 3.6-10.4	0.35	0	69	19	12	100
P VIII.5 C 3.6-10.4	0.30	0	68	18	14	100
P IX.5 L 0-5	0.37	0	85	8	7	100
P IX.5 L 0-5	0.13	0	86	7	7	100
P XII B2 2-7.5	0.58	0	11	38	51	100
P XII B2 2-7.5	0.58	0	21	43	36	100
P XII.5 C 0-6	0.38	0	23	39	38	100
P XII.5 C 0-6	0.46	0	24	38	38	100
P XIII L 0-6	0.40	0	19	39	42	100
P XIII L 0-6	0.41	0	19	41	40	100
C I R 0-8	0.43	0	4	51	45	100
C I R 0-8	0.42	0	4	50	46	100
RPD of Compositing Duplicates (%)						
WR IV R 6-11.5	60	0	2	0	6	0
P VIII.5 C 3.6-10.4	15	0	1	5	15	0
P IX.5 L 0-5	96	0	1	13	0	0
P XII B2 2-7.5	4	0	63	12	34	0
P XII.5 C 0-6	19	0	4	3	0	0
P XIII L 0-6	2	0	0	5	5	0
C I R 0-8	2	0	0	2	2	0
I-Stat of Compositing Duplicates						
WR IV R 6-11.5	0.30	0.00	0.01	0.00	0.03	0.00
P VIII.5 C 3.6-10.4	0.08	0.00	0.01	0.03	0.08	0.00
P IX.5 L 0-5	0.48	0.00	0.01	0.07	0.00	0.00
P XII B2 2-7.5	0.02	0.00	0.31	0.06	0.17	0.00
P XII.5 C 0-6	0.10	0.00	0.02	0.01	0.00	0.00
P XIII L 0-6	0.01	0.00	0.00	0.03	0.02	0.00
C I R 0-8	0.01	0.00	0.00	0.01	0.01	0.00

Table D.1. (Continued)

Analytical TOC Duplicates		TOC (% dry wt) Rep 1	Rep 2	RPD (%)	I-STAT
WR VI L	0-4	0.57	0.58	1.7	0.01
WR III C	0-6.4	0.44	0.44	0.0	0.00
P V R	0-5	0.79	0.80	1.3	0.01
P VIII.5 C	3.6-10.4	0.30	0.32	6.5	0.03
P IX.5 L	0-5	0.13	0.13	0.0	0.00
P XII B2	2-7.5	0.56	0.56	0.0	0.00
P XII.5 R	5.3-11.1	0.80	0.80	0.0	0.00
CB 5	0-4	0.43	0.43	0.0	0.00

Table D.2. Results of Analysis of Compositing Duplicates for Grain Size

Station, Section (ft)	phi / μm	Percent at Size Fraction																
		<-2.25	-2.25	-1.00	0.25	1.25	2	3.25	3.75	4	5	6	7	8	9	10	11	
		>4750	4750-2000	2000-850	850-425	425-250	250-106	106-75	75-62.5	62.5-31.2	31.2-15.6	15.6-7.8	7.8-3.9	3.9-1.9	1.9-0.9	0.9-0.4	<0.4	<0.2
WR IV R 6-11.5 rep 1		0	1	0	1	14	49	3	0	5	6	3	3	3	2	10	NA	N/A
WR IV R 6-11.5 rep 2		0	1	1	1	14	47	3	0	5	5	3	4	2	3	3	7	N/A
P VIII.5 C 3.6-10.4 rep 1		0	0	0	1	3	54	9	2	3	6	5	5	1	2	2	5	2
P VIII.5 C 3.6-10.4 rep 2		0	0	0	1	3	54	8	2	5	5	4	4	2	3	2	5	2
P IX.5 L 0-5 rep 1		0	0	1	5	28	49	2	0	2	1	3	2	1	1	2	3	N/A
P IX.5 L 0-5 rep 2		0	0	1	0	28	50	1	1	1	2	2	2	1	2	1	3	N/A
P XII B2 2-7.5 rep 1		0	0	0	0	0	5	3	3	6	9	10	13	12	9	8	18	4
P XII B2 2-7.5 rep 2		0	0	0	1	4	3	3	10	9	9	13	12	9	6	20	1	NA
P XII.5 C 0-6 rep 1		0	0	0	1	2	13	5	2	9	9	10	11	9	8	19	2	N/A
P XII.5 C 0-6 rep 2		0	0	0	0	3	13	5	3	10	9	9	10	9	6	6	15	2
P XIII L 0-6 rep 1		0	0	0	0	1	9	6	3	8	9	10	12	10	7	7	14	4
P XIII L 0-6 rep 2		0	0	0	0	1	9	6	3	8	10	11	12	10	8	4	16	2
C I R 0-8 rep 1		0	0	0	0	0	1	2	1	9	15	14	13	10	10	8	16	1
C I R 0-8 rep 2		0	0	0	0	0	1	2	1	9	12	15	14	11	9	8	15	3

NR - Analyzed, but no result for this grain size.
NA - Not analyzed.
N/A - Not applicable.

Table D.2. (Continued)

Station, Section (ft)	phi / μm	<-2.25 >4750	-2.25 4750-2000	-1.00 2000-850	0.25 850-425	1.25 425-250	2 250-106	3.25 106-75	3.75 75-62.5	4 62.5-31.2	5 31.2-15.6	6 15.6-7.8	7 7.8-3.9	8 3.9-1.9	9 1.9-0.9	10 0.9-0.4	11 <0.4	<0.2
RPD of Compositing Duplicates (%)																		
WR IV R	6-11.5	0	0	200	0	0	4	0	200	0	18	0	29	40	40	100	200	N/A
P VIII.5 C	3.6-10.4	0	0	0	0	0	0	12	0	50	18	22	22	67	40	0	0	0
P IX.5 L	0-5	0	0	0	0	0	2	67	200	67	67	40	0	0	67	67	0	N/A
P XII B2	2-7.5	0	0	0	200	200	50	0	100	40	0	26	8	29	40	86	179	200
P XIII L	0-6	0	0	0	0	0	0	0	0	0	11	10	0	0	13	55	13	67
P XII.5 C	0-6	0	0	0	200	40	0	0	40	11	0	11	10	0	29	104	152	200
C I R	0-8	0	0	0	0	0	0	0	0	0	22	7	7	10	11	0	6	100
I-stat of Compositing Duplicates																		
WR IV R	6-11.5	0	0	1	0	0	0.02	0	1	0	0.09	0	0.14	0.2	0.2	0.54	1	N/A
P VIII.5 C	3.6-10.4	0	0	0	0	0	0	0.06	0	0.25	0.09	0.11	0.11	0.33	0.2	0	0	0
P IX.5 L	0-5	0	0	0	0	0	0.01	0.33	1	0.33	0.33	0.2	0	0	0.33	0.33	0	N/A
P XII B2	2-7.5	0	0	0	1	1	0.25	0	0.54	0.2	0	0.13	0.04	0.14	0.2	0.43	0.89	1
P XIII L	0-6	0	0	0	0	0	0	0	0	0	0.05	0.05	0	0	0.07	0.27	0.07	0.33
P XII.5 C	0-6	0	0	0	1	0.2	0	0	0.2	0.05	0	0.05	0.48	0	0.14	0.52	0.76	1
C I R	0-8	0	0	0	0	0	0	0	0	0	0.11	0.03	0.04	0.05	0.05	0	0.03	0.5

Table D.3. Quality Control Data for Oil and Grease and Petroleum Hydrocarbons (NA=not analyzed)

Station, Section (ft)		Oil & Grease	Petroleum Hydrocarbons
Method Blanks (mg/kg dry wt)			
Blank 1		6.5	NA
Blank 2		12	NA
Blank 3		15	NA
Blank 4		13	NA
Blank 1C		3.2	NA
Blank 2C		2.6	NA
Blank 3A		11	NA
Blank 4A		11	NA
Compositing Duplicates (mg/kg dry wt)			
WR IV R	6-11.5	35	19
WR IV R	6-11.5	40	19
P VIII.5 C	3.6-10.4	8.8	6.5
P VIII.5 C	3.6-10.4	10	7.5
P IX.5 L	0-5	14	12
P IX.5 L	0-5	18	13
P XII B2	2-7.5	93	25
P XII B2	2-7.5	58	31
P XII.5 C	0-6	15	11
P XII.5 C	0-6	15	6.4
P XIII L	0-6	13	12
P XIII L	0-6	23	15
C I R	0-8	16	18
C I R	0-8	13	6.8
RPD of Compositing Duplicates (%)			
WR IV R	6-11.5	13.3	0.0
P VIII.5 C	3.6-10.4	12.8	14.3
P IX.5 L	0-5	25.0	8.0
P XII B2	2-7.5	46.4	21.4
P XII.5 C	0-6	0.0	52.9
P XIII L	0-6	55.6	22.2
C I R	0-8	20.7	90.3

Table D.3. (Continued)

Station, Section (ft)		Oil & Grease	Petroleum Hydrocarbons
I-Stat of Compositing Duplicates			
WR IV R	6-11.5	0.07	0.00
P VIII.5 C	3.6-10.4	0.06	0.07
P IX.5 L	0-5	0.13	0.04
P XII B2	2-7.5	0.23	0.11
P XII.5 C	0-6	0.00	0.26
P XIII L	0-6	0.28	0.11
C I R	0-8	0.10	0.45
Analytical Duplicates (mg/kg dry wt)			
P IX.5 L	0-5	18	13
P IX.5 L	0-5	16	16
P XII.5 C	0-6	15	11
P XII.5 C	0-6	15	15
P XIII L	0-6	13	12
P XIII L	0-6	11	10
C I R	0-8	16	18
C I R	0-8	14	7.5
RPD of Analytical Duplicates (%)			
P IX.5 L	0-5	11.8	20.7
P XII.5 C	0-6	0.0	30.8
P XIII L	0-6	16.7	18.2
C I R	0-8	13.3	82.4
I-Stat of Analytical Duplicates			
P IX.5 L	0-5	0.06	0.10
P XII.5 C	0-6	0.00	0.15
P XIII L	0-6	0.08	0.09
C I R	0-8	0.07	0.41
Matrix Spike Recoveries (%)			
C I R	0-8	43	50
P XIII L	0-6	96	76
P XII.5 C	0-6	74	80
P IX.5 L	0-5	63	76

Table D.3. (Continued)

Station, Section (ft)		Oil & Grease	Petroleum Hydrocarbons
I-Stat of Compositing Duplicates			
WR IV R	6-11.5	0.07	0.00
P VIII.5 C	3.6-10.4	0.06	0.07
P IX.5 L	0-5	0.13	0.04
P XII B2	2-7.5	0.23	0.11
P XII.5 C	0-6	0.00	0.26
P XIII L	0-6	0.28	0.11
C I R	0-8	0.10	0.45
Analytical Duplicates (mg/kg dry wt)			
P IX.5 L	0-5	18	13
P IX.5 L	0-5	16	16
P XII.5 C	0-6	15	11
P XII.5 C	0-6	15	15
P XIII L	0-6	13	12
P XIII L	0-6	11	10
C I R	0-8	16	18
C I R	0-8	14	7.5
RPD of Analytical Duplicates (%)			
P IX.5 L	0-5	11.8	20.7
P XII.5 C	0-6	0.0	30.8
P XIII L	0-6	16.7	18.2
C I R	0-8	13.3	82.4
I-Stat of Analytical Duplicates			
P IX.5 L	0-5	0.06	0.10
P XII.5 C	0-6	0.00	0.15
P XIII L	0-6	0.08	0.09
C I R	0-8	0.07	0.41
Matrix Spike Recoveries (%)			
C I R	0-8	43	50
P XIII L	0-6	96	76
P XII.5 C	0-6	74	80
P IX.5 L	0-5	63	26

Table D.4. Quality Control Data for Metals in John F. Baldwin Ship Channel Sediments (N/A = not applicable)

Station, Section (ft)	Concentration (mg/kg dry weight except Al)												
	Ag	Al (%)	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Detection Limits (DL)													
Target DL	0.1	0.001	2	0.1	0.1	2	2	0.02	2	2	0.1	0.1	2 -
Lowest Achieved DL	0.03	0.83	1.0	0.01	0.67	9	1	0.02	2	1.9	0.42	0.27	0.9
Maximum Achieved DL	0.03	0.83	1.0	0.01	0.67	9	1	0.02	2	1.9	0.89	0.42	0.9
Method Blanks													
1	0.03	N/A	N/A	<0.014	<0.67	N/A	N/A	0.20	N/A	N/A	N/A	<0.27	N/A
2	N/A	N/A	N/A	N/A	<0.67	N/A	N/A	0.21	N/A	N/A	N/A	<0.27	N/A
3	N/A	N/A	N/A	N/A	<0.67	N/A	N/A	N/A	N/A	N/A	N/A	<0.42	N/A
Standard Reference Materials													
SRM 1646 rep 1	0.07	6.99	8.7	0.33	9.76	82	18.3	0.07	30	28.9	0.81	0.62	131
SRM 1646 rep 2	N/A	6.95	11.1	0.36	9.54	78	19.0	0.06	37	28.4	0.48	0.49	139
SRM 1646 rep 3	N/A	6.56	10.7	N/A	N/A	75	18.7	N/A	37	27.9	0.91	N/A	133
SRM 1646 rep 4	N/A	6.90	11.3	N/A	N/A	91	20.5	N/A	37	27.1	0.60	N/A	133
SRM 1646 rep 5	N/A	6.24	12.5	N/A	N/A	81	21.9	N/A	37	27.0	<0.88	N/A	138
SRM 1646 rep 6	N/A	6.39	9.7	N/A	N/A	76	18.7	N/A	41	28.4	<0.87	N/A	135
SRM 1646	N/A	6.25	11.6	0.36	10.5	76	18	0.063	32	28.2	N/A	N/A	138
Certified Value		± 0.2	± 1.3	± 0.07	± 1.3	± 3	± 3	± 0.012	± 3	± 1.8			± 6
SRM MESS-1 rep 1	0.08	6.22	10.6	0.60	9.68	70	27.6	0.17	32.5	31.3	<0.60	0.77	180.8
SRM MESS-1 rep 2	0.08	5.60	11.7	0.56	8.96	54	25.5	0.16	32.8	31.5	<0.40	0.49	177.3
SRM MESS-1 rep 3	N/A	6.63	9.0	0.66	10.4	66	26.4	N/A	33.6	32.9	<0.85	N/A	178.9
SRM MESS-1 rep 4	N/A	6.57	11.5	0.68	N/A	45	27.6	N/A	33.2	32.0	<0.50	N/A	178.6
SRM MESS-1 rep 5	N/A	5.64	10.8	N/A	N/A	66	26.0	N/A	28.7	32.3	<0.88	N/A	182.3
SRM MESS-1 rep 6	N/A	6.05	11.0	N/A	N/A	64	29.0	N/A	31.1	33.0	<0.85	N/A	177.0
SRM MESS-1	N/A	5.83	10.6	0.59	10.8	71	25.1	0.171	29.5	34.0	0.34	N/A	191
Certified Value		± 0.20	± 1.2	± 0.10	± 1.9	± 11	± 3.8	± 0.014	± 2.7	± 6.1	± 0.06		± 17

Table D.4. (Continued)

Station, Section (ft)		Concentration (mg/kg dry weight except Al)												
		Ag	Al (%)	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
Compositing Duplicates														
WR IV R	6-11.5	0.09	6.78	11.5	0.15	17.7	233	25.3	0.11	96	10.8	<0.84	0.46	79
WR IV R	6-11.5	0.08	7.07	10.2	0.12	17.4	216	24.4	0.05	95	10.0	<0.87	0.47	78
P VIII.5 C	3.6-10.4	0.05	7.76	9.0	0.11	16.3	242	37.8	0.04	112	6.7	<0.86	0.46	83
P VIII.5 C	3.6-10.4	0.06	6.84	8.6	0.12	15.2	291	30.2	0.03	100	9.2	<0.49	0.61	85
P IX.5 L	0-5	0.06	5.70	8.6	0.10	17.8	346	25.4	0.05	100	13.4	<0.86	0.31	77
P IX.5 L	0-5	0.05	7.43	10.5	0.10	17.5	275	22.4	0.06	92	13.8	<0.85	0.46	72
P XII B2	2-7.5	0.08	9.57	16.7	0.16	18.9	289	61.4	0.31	105	14.9	<0.85	0.61	89
P XII B2	2-7.5	0.14	9.02	17.5	0.14	19.7	279	55.6	0.33	107	13.7	0.93	0.46	88
P XII.5 C	0-6	0.08	9.76	17.4	0.23	16.2	234	56.6	0.39	94	17.1	<0.40	0.46	97
P XII.5 C	0-6	0.07	8.94	16.3	0.14	16.6	249	51.2	0.34	100	15.7	<0.41	0.46	94
P XIII L	0-6	0.09	10.27	17.4	0.19	18.1	186	53.0	0.30	88	15.8	0.58	0.62	90
P XIII L	0-6	0.09	10.10	16.8	0.18	17.6	191	53.9	0.29	83	16.8	<0.41	0.62	94
C I R	0-8	0.38	10.47	18.2	0.23	19.2	185	57.3	0.36	93	20.5	<0.60	0.77	103
C I R	0-8	0.13	9.97	19.3	0.21	18.3	182	55.7	0.40	87	23.5	<0.42	0.61	102

Table D.4. (Continued)

Station, Section (ft)		Concentration (mg/kg dry)												
		Ag	Al (%)	As	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Tl	Zn
RPD of Compositing Duplicates (%) (a)														
WR IV R	6-11.5	11.8	4.2	11.6	22.2	1.7	7.6	3.6	75.0	0.9	7.7	N/A	2.2	1.8
P VIII.5 C	3.6-10.4	18.2	12.6	4.1	8.7	7.0	18.4	22.4	28.6	10.3	31.4	N/A	28.0	1.3
P IX.5 L	0-5	18.2	26.4	19.9	0.0	1.7	22.9	12.6	18.2	8.7	2.9	N/A	39.0	7.4
P XII B2	2-7.5	54.5	5.9	4.7	13.3	4.1	3.5	9.9	6.3	2.3	8.4	N/A	28.0	1.8
P XII.5 C	0-6	13.3	8.8	6.5	48.6	2.4	6.2	10.0	13.7	5.4	8.5	N/A	0.0	3.9
P XIII L	0-6	0.0	1.7	3.5	5.4	2.8	2.7	1.7	3.4	5.7	6.1	N/A	0.0	3.8
C I R	0-8	98.0	4.9	5.9	9.1	4.8	1.6	2.8	10.5	6.8	13.6	N/A	23.2	1.4
I-stat of Compositing Duplicates (b)														
WR IV R	6-11.5	0.06	0.02	0.06	0.11	0.01	0.04	0.02	0.38	0.00	0.04	N/A	0.01	0.01
P VIII.5 C	3.6-10.4	0.09	0.06	0.02	0.04	0.03	0.09	0.11	0.14	0.05	0.16	N/A	0.14	0.01
P IX.5 L	0-5	0.09	0.13	0.10	0.00	0.01	0.11	0.06	0.09	0.04	0.01	N/A	0.19	0.04
P XII B2	2-7.5	0.27	0.03	0.02	0.07	0.02	0.02	0.05	0.03	0.01	0.04	N/A	0.14	0.01
P XII.5 C	0-6	0.07	0.04	0.03	0.24	0.01	0.03	0.05	0.07	0.03	0.04	N/A	0.00	0.02
P XIII L	0-6	0.00	0.01	0.02	0.03	0.01	0.01	0.01	0.02	0.03	0.03	N/A	0.00	0.02
C I R	0-8	0.49	0.02	0.03	0.05	0.02	0.01	0.01	0.05	0.03	0.07	N/A	0.12	0.01

(a) RPD = Relative percent difference: the difference between duplicates divided by the mean of the duplicates, multiplied by 100

(b) I-stat = Industrial statistic: the difference between duplicates divided by the sum of the duplicates

Table D.5. Spike Recovery Data for Silver, Cobalt, and Thallium

Station, Section (ft)		Concentration (mg/kg) Sample + Spike	Sample	Amount Recovered	Amount Spiked	Percent Recovery
Silver						
C I R	0-8	0.60	0.38	0.22	0.50	44
P XIII L	0-6	0.54	0.09	0.45	0.50	90
P XII.5 C	0-6	0.52	0.08	0.44	0.50	88
P IX.5 L	0-5	0.50	0.06	0.44	0.50	88
P VIII.5 C	3.6-10.4	0.51	0.05	0.46	0.50	92
WR IV R	0-6	0.77	0.36	0.41	0.50	82
CB 4 A	3.8-11.4	0.49	0.09	0.40	0.50	80
Cobalt						
C I R	0-8	24.6	19.2	5.4	5.0	108
P XIII L	0-6	23.3	18.1	5.2	5.0	104
P XII.5 C	0-6	22.0	16.2	5.8	5.0	116
P IX.5 L	0-5	23.1	17.8	5.3	5.0	106
P VIII.5 C	3.6-10.4	21.4	16.3	5.1	5.0	102
WR IV R	0-6	19.7	15.2	4.5	5.0	90
CB 4 A	3.8-11.4	25.9	20.6	5.3	5.0	106
Thallium						
C I R	0-8	5.93	0.77	5.16	5.00	103
P XIII L	0-6	5.94	0.62	5.32	5.00	106
P XII.5 C	0-6	5.32	0.46	4.86	5.00	97
P IX.5 L	0-5	5.20	0.31	4.89	5.00	98
P VIII.5 C	3.6-10.4	4.84	0.46	4.38	5.00	88
WR IV R	0-6	4.52	0.46	4.06	5.00	81
CB 4 A	3.8-11.4	4.18	0.61	3.57	5.00	71

Table D.6. Quality Control Data for Butyltin Analyses (<=not detected above given detection limit; N/A=not applicable; NS=not spiked)

Sample		Propyl Tin Recovery (%)	Butyltin Concentrations (µg/kg dry) Tetra	Tri	Di	Mono	Total
Detection Limits							
Target DL		N/A	10	10	10	10	N/A
Lowest Achieved DL		N/A	0.41	0.40	0.41	0.42	N/A
Maximum Achieved DL		N/A	2.2	0.80	0.83	2.3	N/A
Method Blanks							
1		66	<0.69	<0.69	<0.68	<0.70	0
2		71	<0.69	<0.68	<0.70	<0.71	0
3		53	<0.68	0.82	0.93	<0.71	1.75
4		113	<0.70	1.1	<0.72	0.75	1.85
5		90	<0.77	2.7	3.7	1.9	8.3
Standard Reference Materials							
PACS-1		52	<3.8	617	752	96	N/A
SQ-1		98	<1.6	58	5.3	<1.7	N/A
Compositing Duplicates							
WR IV R	6-11.5 rep 1	45	<0.55	0.81	<0.55	<0.56	N/A
WR IV R	6-11.5 rep 2	63	<0.44	0.49	0.97	<0.46	N/A
P VIII.5 C	3.6-10.4 rep 1	58	<0.50	<0.49	0.57	<0.52	N/A
P VIII.5 C	3.6-10.4 rep 2	54	<0.60	<0.59	1.1	<0.62	N/A
P IX.5 L	0-5 rep 1	53	<0.48	<0.48	<0.48	<0.49	N/A
P IX.5 L	0-5 rep 2	71	<0.45	0.55	0.56	0.47	N/A
P XII B2	2-7.5 rep 1	45	<0.51	0.89	1.0	2.0	N/A
P XII B2	2-7.5 rep 2	79	<1.6	2.7	11	3.1	N/A
P XII.5 C	0-6 rep 1	42	<0.62	0.67	1.4	0.88	N/A
P XII.5 C	0-6 rep 2	60	<0.78	0.87	<0.77	<0.59	N/A
P XIII L	0-6 rep 1	37	<1.8	6.1	12	3.3	N/A
P XIII L	0-6 rep 2	43	<0.57	<0.57	1.3	0.74	N/A
C I R	0-8 rep 1	41	<0.60	1.7	2.6	0.74	N/A
C I R	0-8 rep 2	64	<0.81	2.9	1.8	1.1	N/A

Table D.6. (Continued)

Station		Propyl Tin Recovery (%)	Butyltin Species Tetra	Tri	Di	Mono	Total
RPD of Compositing Duplicates (%)							
WR IV R	6-11.5	33	N/A	49	N/A	N/A	N/A
P VIII.5 C	3.6-10.4	7	N/A	N/A	64	N/A	N/A
P IX.5 L	0-5	29	N/A	N/A	N/A	N/A	N/A
P XII B2	2-7.5	55	N/A	101	167	43	N/A
P XII.5 C	0-6	35	N/A	26	N/A	N/A	N/A
P XIII L	0-6	48	N/A	N/A	199	195	N/A
C I R	0-8	44	N/A	52	36	39	N/A
I-Stat of Compositing Duplicates							
WR IV R	6-11.5	0	N/A	0.25	N/A	N/A	0.29
P VIII.5 C	3.6-10.4	0	N/A	N/A	0.3	N/A	0.3
P IX.5 L	0-5	0	N/A	N/A	N/A	N/A	1
P XII B2	2-7.5	0	N/A	0.5	0.8	0.2	0.6
P XII.5 C	0-6	0	N/A	0.1	N/A	N/A	1
P XIII L	0-6	0	N/A	N/A	1.0	1.0	1
C I R	0-8	0	N/A	0.3	0.2	0.2	0.1
Matrix Spike Recoveries (%)							
C I R		N/A	NS	58	43	23	N/A
P XIII L		N/A	NS	60	71	45	N/A
P XII.5 C		N/A	NS	52	68	53	N/A
P IX.5 L		N/A	NS	53	72	52	N/A
P VIII.5 C		N/A	NS	69	89	39	N/A
WR IV R		N/A	NS	99	76	82	N/A
CB 4 A		N/A	NS	60	53	33	N/A

Table D.7. Base/Neutral Semivolatile Surrogate Recoveries (%)

Station, Section (ft)		Nitro-benzene-d5	2-Fluoro-biphenyl	Terphenyl-d14
QC Acceptance Range		23-120	30-115	18-137
West Richmond				
WR VII C	0-5.5	44	49	94
WR VI L	0-4	44	59	83
WR V L	0-6	48	54	86
WR IV.5 C	0-4	55	73	69
WR IV.5 C	4-8	48	62	76
WR IV R	0-6	50	53	119
WR IV R	6-11.5	61	66	82
WR IV R	6-11.5	80	91	96
WR III L	0-6.6	54	55	111
WR III C	0-6.4	60	80	94
WR II L	0-6.9	37	54	110
WR I R	0-5.1	68	86	80
Pinole Shoal				
P I C	0-3	34	55	102
P II C	0-4.3	34	37	54
P III L	0-3	70	75	110
P IV R	0-8	57	58	92
P V L	0-8.4	32	34	72
P V C	0-8.7	49	63	130
P V R	0-5	31	43	125
P V R	5-10.5	36	40	67
P VI L	0-5	39	53	73
P VI L	5-11.6	45	58	128
P VI C	0-9	34	34	41
P VI R	0-5	31	29	34
P VI R	5-11.7	33	38	41
P VII C	0-5	43	40	40
P VII C	5-10.1	38	44	74
P VIII L	0-6.6	53	57	55
P VIII L	6.6-9.5	48	43	66
P VIII R	0-8	47	45	42
P VIII R	8-10.5	47	42	36
P VIII.5 C	0-3.6	28	36	59
P VIII.5 C	3.6-10.4	31	34	40
P VIII.5 C	3.6-10.4	47	43	60
P IX C	0-5	33	38	80
P IX C	5-11.8	54	53	56
P IX.5 L	0-5	60	78	113
P IX.5 L	0-5	25	33	56
P IX.5 L	5-10.1	66	81	129

Table D.7. (Continued)

Station, Section (ft)		Nitro-benzene-d5	2-Fluoro-biphenyl	Terphenyl-d14
QC Acceptance Range		23-120	30-115	18-137
Pinole Shoal, cont'd				
P X R	0-6	45	67	103
P X R	6-11.5	89	95	132
P X.5 C	0-5	57	66	101
P X.5 C	5-11	66	72	84
P XI L	0-3.5	77	82	101
P XII R	0-8.5	40	57	81
P XII RR	0-9.2	70	82	110
P XII B2	0-2	76	97	96
P XII B2	2-7.5	78	99	104
P XII B2	2-7.5	109	115	89
P XII B2	7.5-12.5	98	115	126
P XII B1	0-5	68	87	81
P XII B1	5-11.1	77	97	81
P XII.5 C	0-6	36	43	101
P XII.5 C	0-6	37	53	90
P XII.5 R	0-5.3	49	59	68
P XII.5 R	5.3-11.1	25	43	102
P XIII L	0-6	56	56	54
P XIII L	0-6	42	58	75
P XIII R	0-5	76	78	75
P XIII R	5-10	50	52	69
P XIV C	0-4.5	51	69	86
Carquinez Strait				
CB 1	0-6.6	38	58	56
C I R	0-8	31	50	90
C I R	0-8	40	58	99
CB 4 A	0-3.8	80	95	113
CB 4 A	3.8-11.4	54	84	116
CB 5	0-4	69	65	73
CB 6	0-6.5	56	67	60
CB 7	0-3.1	61	61	59
C II C	0-4	97	104	91
C II C	4-6.8	66	61	51
C II R	0-2.4	51	62	84

Table D.8. Quality Control Data for Semivolatile Organics (μg/kg dry weight unless otherwise noted) (<=compound not detected above given detection limit; N/A=not applicable)

Station, Section (ft)	Acenaph-thene	Acenaph-thylene	Anthra-cene	Benzo(a) Anthra-cene	Benzo(a) pyrene	Benzo(b) flouran-thene	Benzo(k) fluoran-thene	Benzo (g,h,i) perylene	Chrysene
Method Blanks									
1	<1.7	<1.7	<1.9	<1.2	<1.5	<1.7	<2.3	<3.1	<1.5
2	<1.7	<1.7	<1.9	<1.2	<1.5	<1.7	<2.3	<3.1	<1.5
3	<1.7	<1.7	<1.9	<1.2	<1.5	<1.7	<2.3	<3.1	<1.5
4	<1.7	<1.7	<1.9	<1.2	<1.5	<1.7	<2.3	<3.1	<1.5
5	<1.7	<1.7	<1.9	<1.2	<1.5	<1.7	<2.3	<3.1	<1.5
6	<1.7	<1.7	<1.9	<1.2	<1.5	<1.7	<2.3	<3.1	<1.5
7	<1.7	<1.7	<1.9	<1.2	<1.5	<1.7	<2.3	<3.1	<1.5
13	<1.7	<1.7	<1.9	<1.2	<1.5	<1.7	<2.3	<3.1	<1.5
LS	<1.7	<1.7	<1.9	<1.2	<1.5	<1.7	<2.3	<3.1	<1.5

Station, Section (ft)	Dibenzo (a,h) anthracene	Fluoran-thene	Fluorene	Indeno-(1,2,3-c,d) pyrene	Naphtha-lene	Phenan-threne	Pyrene
Method Blanks							
1	<1.9	<3.1	<1.7	<2.5	<1.6	<2.0	<3.8
2	<1.9	<3.1	<1.7	<2.5	<1.6	<2.0	<3.8
3	<1.9	<3.1	<1.7	<2.5	<1.6	<2.0	<3.8
4	<1.9	<3.1	<1.7	<2.5	<1.6	<2.0	<3.8
5	<1.9	<3.1	<1.7	<2.5	<1.6	<2.0	<3.8
6	<1.9	<3.1	<1.7	<2.5	<1.6	<2.0	<3.8
7	<1.9	<3.1	<1.7	<2.5	<1.6	<2.0	<3.8
13	<1.9	<3.1	<1.7	<2.5	<1.6	<2.0	<3.8
LS	<1.9	<3.1	<1.7	<2.5	<1.6	<2.0	<3.8

Table D.8. (Continued)

Station, Section (ft)		Acenaph-thene	Acenaph-thylene	Anthra-cene	Benzo(a) Anthra-cene	Benzo(a) pyrene	Benzo(b) flouran-thene	Benzo(k) fluoran-thene	Benzo (g,h,i) perylene	Chrysene
Detection Limits										
Target DL		20	20	20	20	20	20	20	20	20
Lowest Achieved DL		3.1	3.1	3.4	2.2	2.7	3.1	4.1	5.6	2.7
Maximum Achieved DL		6.9	6.9	7.7	4.9	5.8	6.5	9.3	13.0	5.8
Analytical Duplicates										
C I R	0-8	<5.1	<5.1	<5.7	<3.6	<4.5	<5.1	<6.9	<9.3	<4.5
C I R	0-8	<5.5	<5.5	<6.1	<3.9	<4.8	<5.5	<7.4	<10.0	<4.8
P XIII L	0-6	<4.9	<4.9	<5.5	<3.5	<4.4	<4.9	<6.7	<9.0	<4.4
P XIII L	0-6	<5.1	<5.1	<5.7	<3.6	<4.5	<5.1	<6.9	<9.3	<4.5
P XII.5 C	0-6	<5.5	<5.5	<6.2	<3.9	<4.9	<5.5	<7.5	<10.0	<4.9
P XII.5 C	0-6	<4.4	<4.4	<4.9	<3.1	<3.9	<4.4	<6.0	<8.1	<3.9
P IX.5 L	0-5	<3.1	<3.1	<3.4	<2.2	<2.7	<3.1	<4.2	<5.6	<2.7
P IX.5 L	0-5	<3.4	<3.4	<3.8	<2.4	<3.0	<3.4	<4.6	<6.2	<3.0
P VIII.5 C	3.6-10.4	<3.8	<3.8	<4.3	<2.7	<3.4	<3.8	<5.2	<7.0	<3.4
P VIII.5 C	3.6-10.4	<4.1	<4.1	<4.6	<2.9	<3.6	<4.1	<5.6	<7.5	<3.6
WR IV R	0-6	<5.2	<5.2	69	110	220	150	140	150	130
WR IV R	0-6	<5.0	<5.0	29	88	180	120	94	150	100
CB 4 A	3.8-11.4	<5.0	<5.0	<5.6	<3.5	<4.4	<5.0	<6.7	<9.1	<4.4
CB 4 A	3.8-11.4	<5.1	<5.1	<4.8	<3.6	<4.5	<5.1	<6.9	<9.3	<4.5

Table D.8. (Continued)

Station, Section (ft)		Dibenzo (a,h) anthracene	Fluoranthene	Fluorene	Indeno-(1,2,3-c,d) pyrene	Naphthalene	Phenanthrene	Pyrene
Detection Limits								
Target DL		20	20	20	20	20	20	20
Lowest Achieved DL		3.4	5.6	3.1	4.5	2.9	3.6	6.8
Maximum Achieved DL		7.7	12.0	6.9	10.0	6.5	6.9	15.0
Analytical Duplicates (cont'd)								
C I R	0-8	<5.7	<9.3	<5.1	<7.5	<4.8	<6.0	<11.0
C I R	0-8	<6.1	<10.0	<5.5	<8.1	<5.2	<5.5	<12.0
P XIII L	0-6	<5.5	<9.0	<4.9	<7.3	<4.7	<5.8	<11.0
P XIII L	0-6	<5.7	<9.3	<5.1	<7.5	<4.8	<6.0	<11.0
P XII.5 C	0-6	<6.2	<10.0	<5.5	<8.1	<5.2	<6.5	<12.0
P XII.5 C	0-6	<4.9	<8.1	<4.4	<6.5	<4.2	<5.2	<9.9
P IX.5 L	0-5	<3.4	<5.6	<3.1	<4.5	<2.9	<3.6	<6.9
P IX.5 L	0-5	<3.8	<6.2	<3.4	<5.0	<3.2	<4.0	<7.6
P VIII.5 C	3.6-10.4	<4.3	<7.0	<3.8	<5.7	<3.6	<4.5	<8.6
P VIII.5 C	3.6-10.4	<4.6	<7.5	<4.1	<6.1	<3.9	<4.9	<9.2
WR IV R	0-6	<5.9	170	<5.2	100	20	160	410
WR IV R	0-6	<5.6	130	<5.0	110	<4.7	79	270
CB 4 A	3.8-11.4	<5.6	<9.1	<5.0	<7.3	<4.7	<5.8	<11.0
CB 4 A	3.8-11.4	<5.7	<9.3	<5.1	<7.5	<4.8	<6.0	<11.0

Table D.8. (Continued)

Station, Section (ft)		Acenaph-thene	Acenaph-thylene	Anthra-cene	Benzo(a) Anthra-cene	Benzo(a) pyrene	Benzo(b) flouran-thene	Benzo(k) fluoran-thene	Benzo (g,h,i) perylene	Chrysene
RPD of Analytical Duplicates (%)										
C I R	0-8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XIII L	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XII.5 C	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P IX.5 L	0-5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P VIII.5 C	3.6-10.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WR IV R	0-6	N/A	N/A	81.6	22.2	20.0	22.2	39.3	0.0	26.1
CB 4 A	3.8-11.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Station, Section (ft)		Dibenzo (a,h) anthracene	Fluoran-thene	Fluorene	Indeno-(1,2,3-c,d) pyrene	Naphtha-lene	Phenan-threne	Pyrene
RPD of Analytical Duplicates (%)								
C I R	0-8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XIII L	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XII.5 C	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P IX.5 L	0-5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P VIII.5 C	3.6-10.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WR IV R	0-6	N/A	26.7	N/A	9.5	N/A	67.8	41.2
CB 4 A	3.8-11.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table D.8. (Continued)

Station, Section (ft)		Acenaph-thene	Acenaph-thylene	Anthra-cene	Benzo(a) Anthra-cene	Benzo(a) pyrene	Benzo(b) flouran-thene	Benzo(k) fluoran-thene	Benzo (g,h,i) perylene	Chrysene
I-stat of Analytical Duplicates										
C I R	0-8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XIII L	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XII.5 C	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P IX.5 L	0-5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P VIII.5 C	3.6-10.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WR IV R	0-6	N/A	N/A	0.69	0.11	0.10	0.11	0.20	0.00	0.13
CB 4 A	3.8-11.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Station, Section (ft)		Dibenzo (a,h) anthracene	Fluoran-thene	Fluorene	Indeno-(1,2,3-c,d) pyrene	Naphtha-lene	Phenan-threne	Pyrene
I-stat of Analytical Duplicates								
C I R	0-8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XIII L	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XII.5 C	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P IX.5 L	0-5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P VIII.5 C	3.6-10.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WR IV R	0-6	N/A	0.13	N/A	0.05	N/A	0.34	0.21
CB 4 A	3.8-11.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table D.8. (Continued)

Station, Section (ft)		Acenaph-thene	Acenaph-thylene	Anthra-cene	Benzo(a) Anthra-cene	Benzo(a) pyrene	Benzo(b) flouran-thene	Benzo(k) fluoran-thene	Benzo (g,h,i) perylene	Chrysene
Detection Limits										
Target DL		20	20	20	20	20	20	20	20	20
Lowest Achieved DL		3.1	3.1	3.4	2.2	2.7	3.1	4.1	5.6	2.7
Maximum Achieved DL		6.9	6.9	7.7	4.9	5.8	6.5	9.3	13.0	5.8
Compositing Duplicates										
WR IV R	6-11.5	<6.1	<6.1	48.0	62.0	48.0	22.0	35.0	17.0	46.0
WR IV R	6-11.5	<5.6	<5.6	15.0	27.0	32.0	15.0	29.0	<10.4	29.0
P XII.5 C	0-6	<5.5	<5.5	<6.2	<3.9	<4.9	<5.5	<7.5	<10.0	<4.9
P XII.5 C	0-6	<4.4	<4.4	<4.9	<3.1	<3.8	<4.4	<5.9	<7.9	<3.8
P IX.5 L	0-5	<3.1	<3.1	<3.4	<2.2	<2.7	<3.1	<4.2	<5.6	<2.7
P IX.5 L	0-5	<3.7	<3.7	<4.1	<2.6	<3.2	<3.7	<5.0	<6.7	<3.2
P XII B2	2-7.5	<5.7	<5.7	<6.4	<4.0	<5.0	<5.7	<7.7	<10.0	<5.0
P XII B2	2-7.5	<5.4	<5.4	<6.1	<3.8	<4.8	<5.4	<7.3	<9.9	<4.8
P VIII.5 C	3.6-10.4	<3.8	<3.8	<4.3	<2.7	<3.4	<3.8	<5.2	<7.0	<3.4
P VIII.5 C	3.6-10.4	<4.2	<4.2	<4.7	<2.9	<3.7	<4.2	<5.6	<7.6	<3.7
P XIII L	0-6	<4.9	<4.9	<5.5	<3.5	<4.4	<4.9	<6.7	<9.0	<4.4
P XIII L	0-6	<4.8	<4.8	<5.3	<3.4	<4.2	<4.8	<6.5	<8.7	<4.2
C I R	0-8	<5.1	<5.1	<5.7	<3.6	<4.5	<5.1	<6.9	<9.3	<4.5
C I R	0-8	<5.3	<5.3	<5.9	<3.7	<4.7	<5.3	<7.1	<9.6	<4.7

Table D.8. (Continued)

Station, Section (ft)		Dibenzo (a,h) anthracene	Fluoran-thene	Fluorene	Indeno-(1,2,3-c,d) pyrene	Naphtha-lene	Phenan-threne	Pyrene
Detection Limits								
Target DL		20	20	20	20	20	20	20
Lowest Achieved DL		3.4	5.6	3.1	4.5	2.9	3.6	6.8
Maximum Achieved DL		7.7	12.0	6.9	10.0	6.5	6.9	15.0
Compositing Duplicates (cont'd)								
WR IV R	6-11.5	<6.8	97.0	<6.1	<8.9	<5.7	110.0	140.0
WR IV R	6-11.5	<6.3	55.0	<5.6	<8.2	<5.3	42.0	61.0
P XII.5 C	0-6	<6.2	<10.0	<5.5	<8.1	<5.2	<6.5	<12.0
P XII.5 C	0-6	<4.9	<7.9	<4.4	<6.4	<4.1	<5.1	<9.7
P IX.5 L	0-5	<3.4	<5.6	<3.1	<4.5	<2.9	<3.6	<6.9
P IX.5 L	0-5	<4.1	<6.7	<3.7	<5.4	<3.4	<4.3	<8.2
P XII B2	2-7.5	<6.4	<10.0	<5.7	<8.4	<5.4	<6.7	<13.0
P XII B2	2-7.5	<6.1	<9.9	<5.4	<8.0	<5.1	<6.4	<12.0
P VIII.5 C	3.6-10.4	<4.3	<7.0	<3.8	<5.7	<3.6	<4.5	<8.6
P VIII.5 C	3.6-10.4	<4.7	<7.6	<4.2	<6.1	<3.9	<4.9	<9.3
P XIII L	0-6	<5.5	<9.0	<4.9	<7.3	<4.7	<5.8	<11.0
P XIII L	0-6	<5.3	11.0	<4.8	<7.0	<4.5	<5.6	15.0
C I R	0-8	<5.7	<9.3	<5.1	<7.5	<4.8	<6.0	<11.0
C I R	0-8	<5.9	<9.6	<5.3	<7.8	<5.0	<6.2	<12.0

Table D.8. (Continued)

Station, Section (ft)		Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) Anthracene	Benzo(a) pyrene	Benzo(b) flouranthene	Benzo(k) fluoranthene	Benzo (g,h,i) perylene	Chrysene
RPD of Compositing Duplicates (%)										
WR IV R	6-11.5	N/A	N/A	105	78.7	40.0	37.8	18.8	N/A	45.3
P VIII.5 C	3.6-10.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P IX.5 L	0-5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XII B2	2-7.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XII.5 C	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XIII L	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C I R	0-8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Station, Section (ft)		Dibenzo (a,h) anthracene	Fluoranthene	Fluorene	Indeno-Indeno-(1,2,3-c,d) pyrene	Naphthalene	Phenanthrene	Pyrene
RPD of Compositing Duplicates (%)								
WR IV R	6-11.5	N/A	55.3	N/A	N/A	N/A	89.5	78.6
P VIII.5 C	3.6-10.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P IX.5 L	0-5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XII B2	2-7.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XII.5 C	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XIII L	0-6	N/A	2.0	N/A	N/A	N/A	N/A	2.0
C I R	0-8	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table D.8. (Continued)

Station, Section (ft)		Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) Anthracene	Benzo(a) pyrene	Benzo(b) flouranthene	Benzo(k) fluoranthene	Benzo (g,h,i) perylene	Chrysene
I-stat of Compositing Duplicates										
WR IV R	6-11.5	N/A	N/A	0.52	0.39	0.28	0.19	0.09	N/A	0.23
P VIII.5 C	3.6-10.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P IX.5 L	0-5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XII B2	2-7.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XII.5 C	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XIII L	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C I R	0-8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Station, Section (ft)		Dibenzo (a,h) anthracene	Fluoranthene	Fluorene	Indeno-(1,2,3-c,d) pyrene	Naphthalene	Phenanthrene	Pyrene
I-stat of Compositing Duplicates								
WR IV R	6-11.5	N/A	0.28	N/A	N/A	N/A	0.45	0.39
P VIII.5 C	3.6-10.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P IX.5 L	0-5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XII B2	2-7.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XII.5 C	0-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P XIII L	0-6	N/A	1.0	N/A	N/A	N/A	N/A	1.0
C I R	0-8	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table D.8. (Continued)

Station, Section (ft)		Amount Spiked	Acenaph-thene	Acenaph-thyiene	Anthra-cene	Benzo(a) Anthra-cene	Benzo(a) pyrene	Benzo(b) flouran-thene	Benzo(k) fluoran-thene	Benzo (g,h,i) perylene	Chrysene
Matrix Spike Concentrations											
C I R	0-8	51.9	39	39	46	54	33	25	44	40	61
P XIII L	0-6	41.5	21	20	30	40	36	37	37	25	36
P XII.5 C	0-6	43.5	39	37	55	67	53	67	67	37	69
P IX.5 L	0-5	29.6	10	10	15	19	15	22	17	11	20
P VIII.5 C	3.6-10.4	33.5	29	27	35	30	32	34	39	28	30
CB 4 A	3.8-11.4	51.6	41	39	58	52	46	62	51	22	49
WR III L	0-6.6	53.3	37	38	60	48	30	41	43	21	52

Station, Section (ft)		Amount Spiked	Dibenzo (a,h)an-thracene	Fluor-an-thene	Fluorene	Indeno-(1,2,3-c,d) pyrene	Naphtha-lene	Phenan-threne	Pyrene
Matrix Spike Concentrations									
C I R	0-8	51.9	31	44	44	37	25	49	60
P XIII L	0-6	41.5	21	22	24	25	20	31	41
P XII.5 C	0-6	43.5	11	24	21	12	12	26	32
P IX.5 L	0-5	29.6	8.2	16	12	9.3	11	16	24
P VIII.5 C	3.6-10.4	33.5	24	34	30	26	28	37	27
CB 4 A	3.8-11.4	51.6	17	53	45	20	34	59	53
WR III L	0-6.6	53.3	16	59	47	20	32	62	67

Table D.8. (Continued)

Station, Section (ft)		Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) Anthracene	Benzo(a) pyrene	Benzo(b) flouranthene	Benzo(k) fluoranthene	Benzo (g,h,i) perylene	Chrysene
QC Acceptance Range (%) for Spike Recoveries		47-145	33-145	27-133	33-143	17-163	24-159	11-162	D-219	17-168
Matrix Spike Recoveries (%)										
C I R	0-8	75	75	89	104	64	48	85	77	118
P XIII L	0-6	51	48	72	96	87	89	89	60	87
P XII.5 C	0-6	39	37	55	67	53	67	67	37	69
P IX.5 L	0-5	34	34	51	64	51	74	57	37	68
P VIII.5 C	3.6-10.4	87	81	104	90	96	101	116	84	90
CB 4 A	3.8-11.4	79	76	112	101	89	120	99	43	95
WR III L	0-6.6	69	71	113	90	71	77	81	39	98

Station, Section (ft)		Dibenzo (a,h)anthracene	Fluoranthene	Fluorene	Indeno-(1,2,3-c,d) pyrene	Naphthalene	Phenanthrene	Pyrene
QC Acceptance Range (%) for Spike Recoveries		D-227	26-137	59-121	D-171	21-133	54-120	52-115
Matrix Spike Recoveries (%)								
C I R	0-8	60	85	85	71	48	94	116
P XIII L	0-6	51	53	58	60	48	75	99
P XII.5 C	0-6	25	55	48	28	28	60	74
P IX.5 L	0-5	28	54	41	31	37	54	81
P VIII.5 C	3.6-10.4	72	101	90	78	84	110	81
CB 4 A	3.8-11.4	33	103	87	39	66	114	103
WR III L	0-6.6	30	111	88	38	60	116	126

Table D.8. (Continued)

Station, Section (ft)	Acenaph-thene	Acenaph-thylene	Anthra-cene	Benzo(a) Anthra-cene	Benzo(a) pyrene	Benzo(b) flouran-thene	Benzo(k) fluoran-thene	Benzo (g,h,i) perylene	Chrysene
Standard Reference Materials									
SRM HS-3	4.3	0.25	10	15	5.9	7.9	no data	3.5	17
SRM HS-3 Certified Value	4.5±1.5	0.3±0.1	13.4±0.5	14.6±2.0	7.4±3.6	7.7±1.2	2.8±2.0	5.0±2.0	14.1±2.0
SRM SES-1	0.17	N/A	ND	0.25	ND	N/A	N/A	0.76	0.8
SRM SES-1 Certified Value	0.59	N/A	0.92	0.5	0.15	N/A	N/A	0.59	1.1

Station, Section (ft)	Dibenzo (a,h) anthracene	Fluoran-thene	Fluorene	Indeno-(1,2,3-c,d) pyrene	Naphtha-lene	Phenan-threne	Pyrene
SRM HS-3	1.5	43	13	3.3	8.6	83	39
SRM HS-3 Certified Value	1.3±0.5	60±9	13.6±3.1	5.4±1.3	9.0±0.7	85±20	39±9
SRM SES-1	0.73	1.0	0.29	0.79	0.99	1.0	1.7
SRM SES-1 Certified Value	0.6	1.35	0.55	0.8	1.7	1.05	2.4

Table D.9. Quality Control Data for Chlorinated Pesticides and PCBs.

Method Blanks No compounds detected in any method blanks

Compositing Duplicates All compounds undetected in 6 sets of duplicates; in P XII B2, δ-BHC was <8.0 µg/kg in one compositing duplicate and 31 µg/kg in the other. Since δ-BHC was not detected in both duplicates, it was not appropriate to calculate the RPD and I-Stat. This difference in concentration could be due to sample heterogeneity, matrix variability, or analytical reasons.

Analytical Duplicates All compounds undetected in 6 sets of duplicates; in CB 4A 3.6-11.4, δ-BHC was <8.0 µg/kg in one analytical duplicate and 19 µg/kg in the other. Since δ-BHC was not detected in both duplicates, it was not appropriate to calculate the RPD and I-Stat. This difference in concentration could be due to sample heterogeneity, matrix variability, or analytical reasons.

Spike Recoveries (%)		Surrogate: Dibutyl-Chlorendate	Matrix Spike Compounds: Lindane (γ-BHC)	Hepta-chlor	Aldrin	Dieldrin	Endrin	4,4'-DDT	Aroclor 1242
QC Acceptance Limit		(a)	32-127	34-111	42-122	36-146	30-147	26-160	39-150
WR VII C	0-5.5	59	45	45	43	54	58	66	84
P IX.5 L	0-5	92	91	83	100	100	89	100	102
P XII B2	2-7.5	89	89	79	99	89	91	98	99
P XII.5 R	5.3-11.1	92	94	80	86	96	106	110	70
P XIII L	0-6	82	NS(b)	NS	NS	NS	NS	NS	89
C I R	0-8	84	73	68	70	93	88	90	78
CB 6	0-6.5	75	69	66	77	92	77	101	73

(a) Limits not calculated for fewer than 30 recoveries (EPA SW846 Method 8000)
(b) NS=Not Spiked.

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11/28/90