UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

TIME-SEQUENCE MEASUREMENTS OF ESTUARINE HYDROGRAPHY AND SUSPENDED SEDIMENTS IN CORPUS CHRISTI BAY, TEXAS

by

Gerald L. Shideler and Charles E. Stelting

OPEN-FILE REPORT 82-472

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards. Use of brand names in this report is for purposes of identification only and does not imply endorsement by the USGS.

1982

CONTENTS

ILLUSTRATION

TABLES

INTRODUCTION

This report contains time-sequence field and laboratory measurements of hydrographic parameters and suspended-sediment characteristics within the Corpus Christi Bay estuarine system of south Texas. Corpus Christi Bay is a restricted "bar-built" variety of estuary (Schubel, 1971), which is typical of the Texas Gulf Coast (Fig. 1). The bay is separated from the Gulf of Mexico by the Mustang Island barrier, and the bay's main tidal inlet (Aransas Pass) is near the city of Port Aransas, Texas. The main fluvial input into the estuarine system is from the Nueces River, which discharges into shallow (<2 m deep) subsidiary Nueces Bay. In turn, Nueces Bay has water exchange with Corpus Christi Bay through a causeway-connected inlet. Minor stream discharge enters Corpus Christi Bay along its south shore from the shallow (<1 m deep) Oso Bay tributary; Corpus Christi Bay also has water exchange with Redfish Bay to the north and Laguna Madre to the south. The depth of Corpus Christi Bay is generally less than 5 m, except along the main ship channel which is maintained for navigation by dredging to a depth of approximately 14 m. The bottom sediment of both Corpus Christi and Nueces Bays is mainly mud within the interiors and sand along the margins (Shideler and others, 1981).

The time-sequence hydrographic and suspended-sediment measurements presented in this report were obtained by eight helicopter surveys conducted during a 25-month observational period (March 1978 to April 1980). The purpose of these time-sequence measurements was to provide a data base for investigating estuarine processes within Corpus Christi Bay. The need for these measurements was indicated by an earlier reconnaissance study of the Bay's turbidity structure (Shideler, 1980), a study which indicated high variability of bay conditions in time and space. The present report

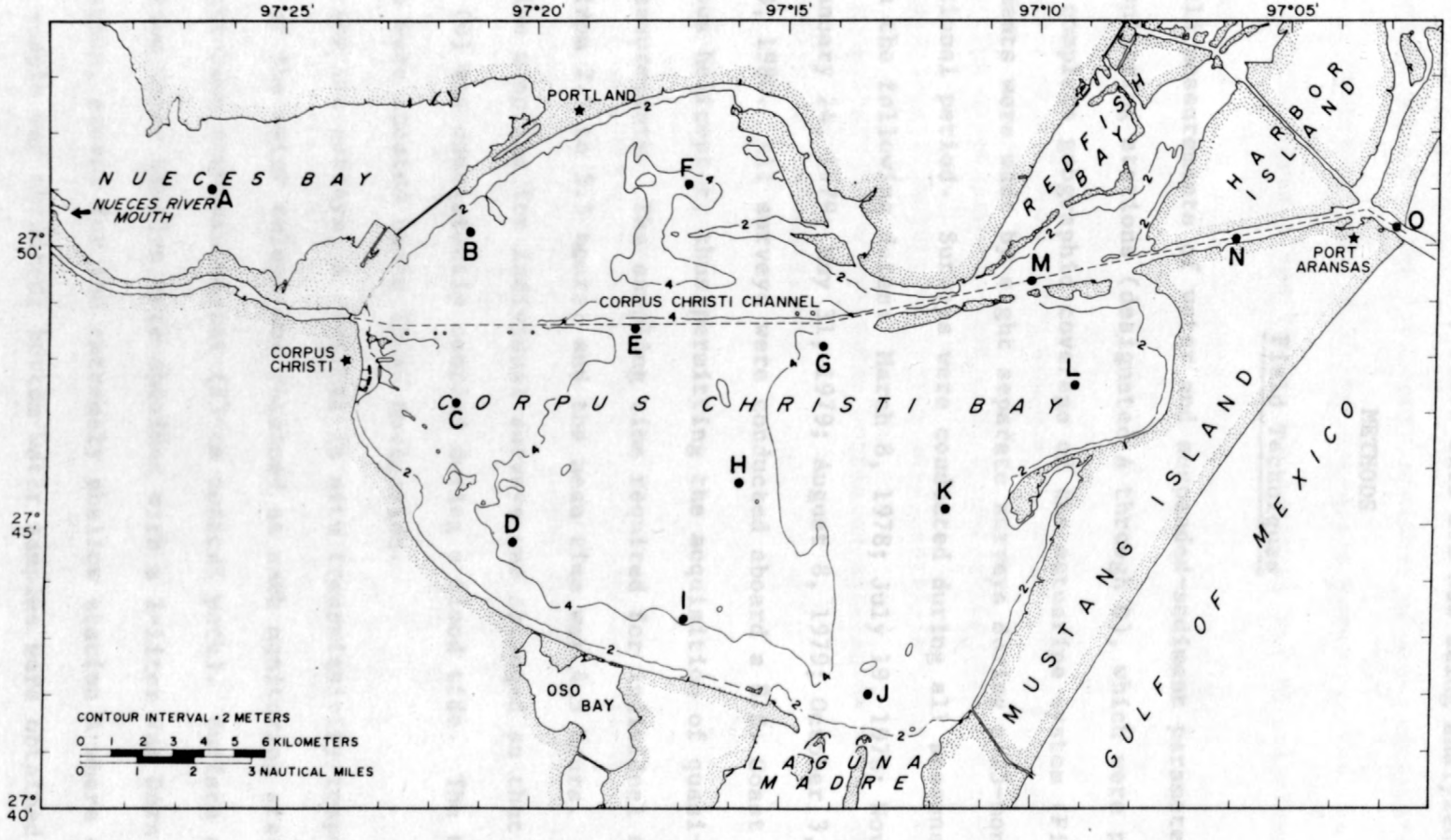

Figure 1. Corpus Christi Bay bathymetry and locations of monitoring stations (A-O).

contains the basic field and laboratory measurements of hydrographic and suspended-sediment parameters; these data are now being analyzed.

METHODS

Field Techniques

Field measurements of water and suspended-sediment parameters were made at 15 monitoring stations (designated A through O), which were positioned to provide complete geographic coverage of the estuarine system (Fig. 1). The measurements were made by eight separate surveys during a 25-month observational period. Surveys were conducted during all seasons and took place on the following dates: March 8, 1978; July 19, 1978; November 29, 1978; January 24, 1979; May 31, 1979; August 8, 1979; October 3, 1979; and April 23, 1980. All surveys were conducted aboard a U.S. Coast Guard amphibious helicopter, thus permitting the acquisition of quasi-synoptic field measurements. The sampling time required for individual surveys ranged from 2.5 to 5.5 hours, and the mean time was 4.3 hours. The sequence of station sampling for individual surveys was arranged so that the inlet station (O) was consistently sampled during a flood tide. The sample stations were located using TACAN navigation.

During the surveys, a vertical in situ transmissivity/temperature profile of the water column was obtained at each monitoring station by use of a light-beam transmissometer (25-cm optical path). Surface and near-bottom water samples were obtained with a 3-liter Van Dorn bottle at each station, except for the extremely shallow station A where only a surface sample was obtained; bottom-water samples were obtained from 0.5 to 1.0 m above the bay floor. From each bulk water sample, a 1-liter subsample was immediately transferred to a particle-free amber polypropylene bottle

containing sufficient particle-free formaldehyde to result in a 5 percent (by volume) formaldehyde solution; the formaldehyde was added to inhibit organic growth prior to the laboratory analyses of suspended-sediment texture and concentration. A 250-ml untreated subsample was transferred to a particle-free polyethylene bottle for salinity and pH measurements in the laboratory.

Laboratory Techniques

A total of 232 bulk water samples was collected during the eight surveys. The subsamples treated with formaldehyde were analyzed for suspended-sediment properties (total mass, particle counts, textures, organic constituents), whereas the untreated subsamples were analyzed for water properties (salinity, pH).

Water Analysis

The pH measurements of untreated water samples were made with a Beckman pH meter immediately upon opening the sample containers under ambient laboratory conditions. Water salinities (in parts per thousand, ppt) were determined with an induction salinometer, using a Copenhagen seawater standard. Water densities were calculated from salinity and in-situ temperature measurements. The water densities are expressed as sigma-t values [σ_t = (density-1) x 1000].

Coulter Counter Analysis of Suspended Sediment

The formaldehyde-treated water samples were analyzed for both the particle concentrations and textures of suspended particulate matter by means of a 16-channel model TA Coulter Counter. The particulate matter was analyzed in its natural state, using a particle-free baywater diluent

containing 5 percent (by volume) formaldehyde. All Coulter analyses were conducted using a combination of 200-µm- and 30-µm-tube apertures, thus providing analyses of particles within the 0.63-to-81-µm size range. The large volume of particle-free diluent required in routine operations for both sample dilution and glassware/sieve washings was provided by a continuously recirculating filtration (0.2-µm microporous filter) system that allowed the reclamation of used diluent. For background information on the principles and techniques of sediment analyses by Coulter Counter, the reader is referred to the following earlier works: Coulter (1956), Inter-agency Committee on Water Resources (1964), Sheldon and Parsons (1967), Allen (1968), Walker and Hutka (1971), Swift and others (1972), McCave and Jarvis (1973), Walker and others (1974), Coulter Electronics (1975), Shideler (1976), and Behrens (1978).

Particle-concentration analyses.--To provide an index of water turbidity, the concentrations of suspended particulate matter were determined in terms of the total number of particles per unit water volume (particle counts/cubic centimeter). Particle counts were made using the following standardized procedures:

(1) The water sample was brought to ambient temperature, thoroughly agitated to minimize any possible particle loss by adhesion to the storage bottle interior, and then passed through a 125-µm sieve to remove large particles capable of blocking the 200-µm-tube aperture.

(2) Counts of the coarser particles (12.7-to-81-µm size range) were first made using the 200 µm tube. Particle counts were made on a 2-cc aliquot from a 150-ml initial water sample volume; the aliquot was analyzed full strength while being stirred in the sample beaker at a standard speed. To eliminate possible anomalous counts resulting from extraneous factors

(electronic noise, microphonic vibrations, etc.), duplicate counts were made; if they agreed within ±10 percent, the counts were considered valid and the average value was used. If the deviation was greater than ±10 percent, the counts were discarded; additional counts were then made until the deviation between two consecutive counts was within the ±10-percent limits.

(3) The residual sample from the 200-µm-tube analysis was passed through a 20-µm micromesh sieve and then used for the 30-µm-tube analysis to obtain counts of the finer particles (0.63-to-12.7-µm size range). The sieved sample was agitated on a magnetic stirrer, and subsamples were incrementally added to the analytical beaker that contained 150 ml of agitated particle-free baywater diluent. Sample was added to the diluent until a standard particle concentration of 3 percent was achieved. Dilution was necessary for more efficient and accurate counting of the large number of particles within the finer size grades. After the standard concentration was obtained, duplicate counts (within ±10 percent) were made on the sample without stirring, using a .05 cc aliquot; the average count value was then adjusted by the dilution factor.

(4) Particle counts from both the 200-µm- and 30-µm-tube analyses were arithmetically combined and normalized to unit volume, which provided total counts/cubic centimeter of all suspended particulate matter within the 0.63-81-µm size range.

(5) During particle-concentration analyses, precautions were taken to avoid extraneous particle counts that might result from a combination of particulate contamination (dirty glassware, sieves, or diluent), electronic noise, electromagnetic radiation, or microphonic vibrations. Because particle counts could change as a function of time, either as a result of

container adhesion or changes in the degree of flocculation, the time between field sampling and particle-concentration analyses was minimized.

Textural analyses.--The size-frequency distribution of suspended particulate matter within the 0.63-to-81-μm size range was determined on a separate split of the subsamples designated for Counter analyses. The same general precautions recommended for the routine textural analysis of mud (<63 μm) by Coulter Counter, as described elsewhere (Shideler, 1976), were used. However, the analysis of low concentrations of suspended matter required different procedures, as follows:

(1) The water sample was brought to ambient temperature, thoroughly agitated, and passed through a 125-μm sieve to remove particles capable of blocking the 200-μm-tube aperture.

(2) A standard initial 100-ml sample volume was placed in the analytical beaker, and the size distribution of the coarser particles (12.7-to-81-μm size range) was determined by a 200-μm-tube analysis. The sample was run at particle concentrations of less than 3 percent (diluted with particle-free baywater if necessary), in order to standardize any possible coincidence error at a consistent and minimal level. During analysis, the sample was stirred at a standard speed.

(3) The residual sample from the 200-μm-tube analysis was passed through a 20-μm micromesh sieve, then used for the 30-μm-tube analysis to obtain the size distribution of the finer particle fraction (0.63-μm to 12.7-μm size range). No stirring was used during the 30-μm-tube analysis.

(4) The differential volume percentage data from both the 200-μm- and 30-μm-tube analyses were combined to obtain the total size distribution of suspended particulate matter, using standard two-tube overlap techniques (Coulter Electronics, 1975). Statistical grain-size parameters were then

determined by computer for a 3.5ϕ to 11.0ϕ analytical size range. Derived parameters are the following: silt/clay ratios, modal diameters, and the four moment measures (mean diameter, standard deviation, skewness, kurtosis). The statistical grain-size parameters are expressed in terms of Krumbein's (1934) phi scale ($\phi = -\log_2 D$, where D = diameter in millimeters).

Gravimetric Analysis of Suspended Sediment

Mass determinations (in milligrams per liter) of total suspended particulate matter in the formaldehyde-treated water samples were made by filtering the samples through weighed, prewashed 0.45-μm millipore filters. Salt was then removed from the sediment residue by the filtration of deionized water. The filters were dried over magnesium perchlorate desiccant and reweighed to determine total sediment mass. After mass determinations, the sample residues (excluding sample suites CCHS6, CCHS7, and CCHS8) were examined with a scanning electron microscope. Photomicrographs of the sediment residues at a magnification of 300x were point counted (200 counts) to determine the frequency percentages of suspended organic (skeletal) constituents, which consist mainly of phytoplankton remains.

EXPLANATION FOR TABLES 1-8

Sample number designations: CCHS = Corpus Christi Bay Hydrologic Study, fifth character = sample suite number, sixth character = station locality, seventh character = water sample level (T = Top, B = Bottom).

Column 1 - Station latitude (decimal degrees north)

Column 2 - Station longitude (decimal degrees west)

Column 3 - Water-sample depth (meters)

Column 4 - Water-sample pH

Column 5 - Water-sample in situ temperature (°C)

Column 6 - Water-sample salinity (parts per thousand)

Column 7 - Water-sample density (σt)

Column 8 - Water-sample in situ light transmissivity (% transmission/0.25 m)

Column 9 - Water-sample total suspended-sediment mass (milligrams per liter)

Column 10 - Water-sample suspended organic matter (frequency percentage of skeletal constituents)

Column 11 - Water-sample suspended sediment (0.63-81-um size range) concentrations in terms of particle counts x 10^5 per cubic centimeter

Column 12 - Suspended-sediment silt/clay ratio

Column 13 - Suspended-sediment modal diameter in phi units (ϕ)

Column 14 - Suspended-sediment mean diameter (first moment) in phi units (ϕ)

Column 15 - Suspended-sediment standard deviation (second moment) in phi units (ϕ)

Column 16 - Suspended-sediment skewness (third moment)

Column 17 - Suspended-sediment kurtosis (fourth moment)

Note: The designation "ND" indicates no data for a particular parameter.

Table 1. March 8, 1978 Survey (CCHS1)

SAMPLE	LAT	LONG	DEP	PH	TEMP	SAL	SIG T
	1	2	3	4	5	6	7
CCHS1-A	27.85055	97.44055	0.0	6.208	16.0	32.252	23.65
CCHS1-B-T	27.83777	97.35722	0.0	6.520	13.5	32.193	24.13
CCHS1-B-B	27.83777	97.35722	1.0	6.426	13.5	31.921	23.92
CCHS1-C-T	27.78722	97.36027	0.0	7.003	15.0	30.583	22.58
CCHS1-C-B	27.78722	97.36027	3.0	7.293	15.0	30.601	22.60
CCHS1-D-T	27.74583	97.34111	0.0	8.053	13.5	30.855	23.10
CCHS1-D-B	27.74583	97.34111	2.0	7.678	13.5	30.859	23.11
CCHS1-E-T	27.81000	97.30055	0.0	8.069	13.5	30.562	22.87
CCHS1-E-B	27.81000	97.30055	11.0	7.862	13.5	30.642	22.96
CCHS1-F-T	27.85194	97.28333	0.0	7.937	13.5	30.724	23.00
CCHS1-F-B	27.85194	97.28333	3.0	7.773	14.0	30.720	22.90
CCHS1-G-T	27.80416	97.23750	0.0	6.856	13.5	30.720	23.00
CCHS1-G-B	27.80416	97.23750	3.0	7.416	13.5	30.766	23.04
CCHS1-H-T	27.76250	97.26444	0.0	7.529	13.5	30.642	22.93
CCHS1-H-B	27.76250	97.26444	3.0	7.701	13.5	30.687	22.97
CCHS1-I-T	27.72250	97.28277	0.0	7.759	13.5	31.015	23.23
CCHS1-I-B	27.72250	97.28277	3.0	7.198	13.5	31.008	23.23
CCHS1-J-T	27.70027	97.22111	0.0	7.640	13.5	30.802	23.06
CCHS1-J-B	27.70027	97.22111	3.0	7.556	13.5	30.853	23.10
CCHS1-K-T	27.75583	97.19666	0.0	7.637	13.5	30.821	23.07
CCHS1-K-B	27.75583	97.19666	3.0	7.356	13.5	30.781	23.04
CCHS1-L-T	27.79222	97.15472	0.0	7.584	13.5	30.938	23.18
CCHS1-L-B	27.79222	97.15472	2.5	7.734	13.5	30.939	23.18
CCHS1-M-T	27.82305	97.16972	0.0	7.853	13.5	30.739	23.02
CCHS1-M-B	27.82305	97.16972	12.0	7.790	13.5	30.739	23.02
CCHS1-N-T	27.83527	97.10361	0.0	7.650	13.5	30.695	22.99
CCHS1-N-B	27.83527	97.10361	13.0	7.626	13.5	30.755	23.03
CCHS1-O-T	27.83888	97.04916	0.0	7.756	13.5	26.616	19.86
CCHS1-O-B	27.83888	97.04916	13.0	7.653	12.5	30.837	23.29

Table 1. March 8, 1978 Survey (CCHS1)--Continued

SAMPLE	TRANS	MASS	%ORG	PC	S/CL	MODE	MEAN	STDV	SKEW	KURT
	8	9	10	11	12	13	14	15	16	17
CCHS1-A	0.0	175.6	10.5	298.5	0.43	8.17	8.62	1.25	-0.20	-0.24
CCHS1-B-T	2.0	84.4	32.2	114.1	0.58	8.16	8.39	1.29	-0.17	-0.24
CCHS1-B-B	1.0	39.6	20.0	72.3	0.50	8.18	8.50	1.24	-0.19	-0.06
CCHS1-C-T	11.0	22.0	31.0	40.0	0.67	8.17	8.24	1.47	-0.18	-0.63
CCHS1-C-B	10.0	18.4	25.0	44.4	0.65	9.13	8.26	1.51	-0.22	-0.51
CCHS1-D-T	3.0	36.8	27.0	65.2	0.73	8.14	8.14	1.44	-0.23	-0.22
CCHS1-D-B	0.0	46.4	29.5	66.3	0.78	8.12	8.10	1.46	-0.20	-0.38
CCHS1-E-T	8.0	20.8	29.5	53.7	0.56	8.17	8.37	1.39	-0.26	-0.12
CCHS1-E-B	0.0	32.8	37.5	76.3	0.47	9.17	8.53	1.32	-0.28	0.02
CCHS1-F-T	10.0	18.8	43.0	53.0	0.67	8.16	8.23	1.43	-0.23	-0.13
CCHS1-F-B	9.0	21.6	52.0	49.9	0.61	8.14	8.32	1.39	-0.24	-0.07
CCHS1-G-T	5.0	22.4	30.0	52.6	0.62	8.13	8.29	1.39	-0.25	-0.09
CCHS1-G-B	3.0	32.0	27.5	49.0	0.65	8.10	8.25	1.39	-0.26	0.15
CCHS1-H-T	3.0	31.6	41.5	64.1	0.55	8.13	8.37	1.34	-0.31	0.39
CCHS1-H-B	1.0	34.0	58.5	54.4	0.65	8.10	8.26	1.27	-0.26	0.45
CCHS1-I-T	1.0	38.4	33.8	62.9	0.60	8.12	8.28	1.30	-0.36	0.97
CCHS1-I-B	1.0	47.2	36.0	65.1	0.66	8.10	8.25	1.22	-0.26	0.62
CCHS1-J-T	2.0	35.6	45.4	50.9	0.67	8.10	8.23	1.23	-0.26	0.60
CCHS1-J-B	1.0	38.8	54.5	51.4	0.83	8.06	8.05	1.31	-0.31	0.88
CCHS1-K-T	2.0	38.0	31.3	60.2	0.66	8.10	8.26	1.25	-0.22	0.25
CCHS1-K-B	1.0	42.4	23.0	60.9	0.76	8.09	8.15	1.30	-0.23	0.34
CCHS1-L-T	12.0	20.8	34.0	29.9	0.89	8.10	8.00	1.40	-0.18	-0.17
CCHS1-L-B	11.0	28.8	45.0	30.6	0.90	8.08	7.98	1.42	-0.20	-0.13
CCHS1-M-T	9.0	24.8	36.0	47.9	0.64	9.15	8.16	1.65	-0.32	-0.27
CCHS1-M-B	4.0	27.2	34.0	50.8	0.72	8.17	8.14	1.49	-0.24	-0.30
CCHS1-N-T	21.0	16.8	32.5	29.4	0.75	8.12	8.14	1.45	-0.22	-0.22
CCHS1-N-B	11.0	23.2	40.0	29.5	0.90	8.10	7.95	1.50	-0.20	-0.28
CCHS1-O-T	14.0	21.6	36.0	29.4	0.80	8.09	8.10	1.40	-0.21	0.00
CCHS1-O-B	0.0	59.6	41.5	65.2	0.91	8.08	7.93	1.44	-0.26	-0.04

Table 2. July 19, 1978 Survey (CCHS2)

SAMPLE	LAT	LONG	DEP	PH	TEMP	SAL	SIG T
	1	2	3	4	5	6	7
CCHS2-A	27.85055	97.44055	0.0	7.983	33.0	27.056	14.80
CCHS2-B-T	27.83777	97.35722	0.0	8.199	34.0	32.588	18.50
CCHS2-B-B	27.83777	97.35722	1.5	8.234	34.0	32.562	18.49
CCHS2-C-T	27.78722	97.36027	0.0	8.192	33.0	33.114	19.29
CCHS2-C-B	27.78722	97.36027	2.5	8.549	33.0	33.085	19.27
CCHS2-D-T	27.74583	97.34111	0.0	8.279	34.0	33.796	19.33
CCHS2-D-B	27.74583	97.34111	2.0	8.736	33.0	33.703	19.74
CCHS2-E-T	27.81000	97.30055	0.0	8.250	33.0	32.637	18.94
CCHS2-E-B	27.81000	97.30055	7.0	8.179	31.0	33.195	20.08
CCHS2-F-T	27.85194	97.28333	0.0	8.330	33.0	34.365	20.22
CCHS2-F-B	27.85194	97.28333	2.5	8.273	33.0	34.352	20.19
CCHS2-G-T	27.80416	97.23750	0.0	8.134	31.0	35.624	21.86
CCHS2-G-B	27.80416	97.23750	3.0	8.161	31.0	35.564	21.82
CCHS2-H-T	27.76250	97.26444	0.0	8.162	33.0	35.686	21.20
CCHS2-H-B	27.76250	97.26444	3.0	9.000	33.0	35.652	21.17
CCHS2-I-T	27.72250	97.28277	0.0	8.223	33.0	34.516	22.34
CCHS2-I-B	27.72250	97.28277	3.0	8.256	33.0	37.003	22.18
CCHS2-J-T	27.70027	97.22111	0.0	8.358	33.0	36.896	22.12
CCHS2-J-B	27.70027	97.22111	2.5	8.313	33.0	38.722	23.48
CCHS2-K-T	27.75583	97.19666	0.0	8.520	33.0	35.332	20.93
CCHS2-K-B	27.75583	97.19666	3.0	8.613	33.0	35.550	21.10
CCHS2-L-T	27.79222	97.15472	0.0	8.161	31.0	34.981	21.40
CCHS2-L-B	27.79222	97.15472	2.0	8.197	31.0	35.006	21.41
CCHS2-M-T	27.82305	97.16972	0.0	8.546	28.0	34.970	22.40
CCHS2-M-B	27.82305	97.16972	12.0	8.173	28.0	34.866	22.32
CCHS2-N-T	27.83527	97.10361	0.0	8.204	27.0	34.818	22.61
CCHS2-N-B	27.83527	97.10361	13.0	8.264	27.0	34.762	22.55
CCHS2-O-T	27.83888	97.04916	0.0	8.182	28.0	34.711	22.20
CCHS2-O-B	27.83888	97.04916	13.0	8.229	26.0	34.652	22.78

Table 2. July 19, 1978 Survey (CCHS2)--Continued

SAMPLE	TRANS	MASS	%ORG	PC	S/CL	MODE	MEAN	STDV	SKEW	KURT
	8	9	10	11	12	13	14	15	16	17
CCHS2-A	3.0	110.8	18.0	299.6	0.64	8.70	8.12	1.68	-0.28	-0.60
CCHS2-B-T	3.0	46.4	18.0	133.2	0.45	8.18	8.54	1.24	-0.25	0.13
CCHS2-B-B	0.0	43.6	20.5	142.7	0.39	9.10	8.63	1.24	-0.32	0.61
CCHS2-C-T	4.0	26.8	17.5	93.2	0.62	8.13	8.34	1.39	-0.22	-0.12
CCHS2-C-B	2.0	138.0	20.0	104.5	0.58	8.14	8.37	1.37	-0.27	0.19
CCHS2-D-T	15.0	8.8	15.6	44.1	0.64	8.13	8.26	1.45	-0.25	-0.07
CCHS2-D-B	17.0	10.4	26.1	49.6	0.59	8.14	8.34	1.43	-0.25	-0.06
CCHS2-E-T	9.0	12.4	20.0	53.9	0.66	8.10	8.25	1.43	-0.26	0.03
CCHS2-E-B	1.0	20.0	14.7	73.4	0.64	8.10	8.31	1.35	-0.23	0.16
CCHS2-F-T	15.0	9.6	17.1	46.7	0.57	8.15	8.35	1.42	-0.29	0.18
CCHS2-F-B	12.0	10.0	20.0	52.0	0.63	8.14	8.31	1.40	-0.24	-0.04
CCHS2-G-T	12.0	17.2	12.5	46.5	0.93	8.09	7.95	1.49	-0.16	-0.40
CCHS2-G-B	5.0	121.2	5.0	44.6	0.91	8.07	7.94	1.50	-0.22	-0.14
CCHS2-H-T	13.0	14.4	6.0	62.9	0.49	8.15	8.44	1.42	-0.29	0.08
CCHS2-H-B	10.0	19.6	11.9	67.0	0.46	8.16	8.48	1.39	-0.31	0.26
CCHS2-I-T	13.0	10.4	20.0	60.9	0.53	8.14	8.39	1.40	-0.30	0.33
CCHS2-I-B	7.0	12.4	12.0	82.8	0.35	8.19	8.63	1.18	-0.24	0.63
CCHS2-J-T	21.0	5.4	ND	61.1	0.42	8.17	8.53	1.53	-0.38	0.33
CCHS2-J-B	8.0	43.6	2.1	76.0	0.39	8.19	8.41	1.61	-0.49	0.76
CCHS2-K-T	10.0	11.6	26.5	66.5	0.59	8.13	8.30	1.42	-0.28	0.24
CCHS2-K-B	17.0	10.0	25.0	54.1	0.50	8.16	8.35	1.54	-0.40	0.50
CCHS2-L-T	11.0	11.6	28.5	44.9	0.63	8.14	8.26	1.40	-0.25	0.05
CCHS2-L-B	11.0	10.4	23.9	47.6	0.69	8.14	8.18	1.46	-0.24	-0.05
CCHS2-M-T	26.0	13.6	20.4	28.8	1.19	8.03	7.50	1.75	-0.20	-0.68
CCHS2-M-B	17.0	19.2	16.0	35.2	1.35	8.08	7.37	1.76	-0.14	-0.85
CCHS2-N-T	42.0	8.4	15.5	19.2	1.39	8.04	7.34	1.73	-0.18	-0.67
CCHS2-N-B	40.0	9.6	19.5	22.2	1.38	8.07	7.36	1.73	-0.16	-0.72
CCHS2-O-T	63.0	4.8	11.0	12.9	1.35	7.75	7.49	1.66	-0.17	-0.49
CCHS2-O-B	33.0	7.6	11.0	12.4	1.65	7.23	7.36	1.58	-0.11	-0.61

Table 3. November 29, 1978 Survey (CCHS3)

SAMPLE	LAT	LONG	DEP	PH	TEMP	SAL	SIG T
	1	2	3	4	5	6	7
CCHS3-A	27.85055	97.44055	0.0	7.135	15.6	26.823	19.60
CCHS3-B-T	27.83777	97.35722	0.0	8.082	16.0	26.412	19.19
CCHS3-B-B	27.83777	97.35722	2.5	7.686	18.0	28.998	20.71
CCHS3-C-T	27.78722	97.36027	0.0	7.875	18.0	28.990	20.70
CCHS3-C-B	27.78722	97.36027	3.0	7.948	18.0	29.348	20.98
CCHS3-D-T	27.74583	97.34111	0.0	8.165	18.0	29.855	21.36
CCHS3-D-B	27.74583	97.34111	2.5	8.009	18.0	29.853	21.36
CCHS3-E-T	27.81000	97.30055	0.0	7.964	18.0	29.393	21.01
CCHS3-E-B	27.81000	97.30055	10.0	8.001	18.0	29.524	21.12
CCHS3-F-T	27.85194	97.28333	0.0	7.957	18.0	29.339	20.97
CCHS3-F-B	27.85194	97.28333	3.0	8.020	18.0	29.390	21.01
CCHS3-G-T	27.80416	97.23750	0.0	8.011	18.0	29.173	20.84
CCHS3-G-B	27.80416	97.23750	3.5	7.961	18.0	29.173	20.84
CCHS3-H-T	27.76250	97.26444	0.0	7.957	18.0	29.461	21.07
CCHS3-H-B	27.76250	97.26444	3.5	7.912	18.0	29.481	21.09
CCHS3-I-T	27.72250	97.28277	0.0	7.944	18.0	29.805	21.33
CCHS3-I-B	27.72250	97.28277	3.5	7.982	17.2	29.551	21.32
CCHS3-J-T	27.70027	97.22111	0.0	7.967	18.0	29.521	21.11
CCHS3-J-B	27.70027	97.22111	3.5	7.896	16.7	29.529	21.42
CCHS3-K-T	27.75583	97.19666	0.0	7.986	18.0	29.229	20.89
CCHS3-K-B	27.75583	97.19666	3.5	7.980	17.9	29.417	21.05
CCHS3-L-T	27.79222	97.15472	0.0	8.002	18.0	28.402	20.26
CCHS3-L-B	27.79222	97.15472	3.0	7.934	18.0	28.925	20.66
CCHS3-M-T	27.82305	97.16972	0.0	7.889	18.3	28.944	20.61
CCHS3-M-B	27.82305	97.16972	13.5	7.838	18.2	29.244	20.85
CCHS3-N-T	27.83527	97.10361	0.0	8.013	17.9	27.547	19.65
CCHS3-N-B	27.83527	97.10361	12.0	7.915	18.6	29.218	20.73
CCHS3-O-T	27.83888	97.04916	0.0	8.051	17.2	22.470	15.93
CCHS3-O-B	27.83888	97.04916	11.5	7.800	18.5	28.634	20.31

Table 3. November 29, 1978 Survey (CCHS3)--Continued

SAMPLE	TRANS	MASS	%ORG	PC	S/CL	MODE	MEAN	STDV	SKEW	KURT
	8	9	10	11	12	13	14	15	16	17
CCHS3-A	10.2	10.8	5.1	32.0	0.46	8.21	8.51	1.18	-0.25	0.50
CCHS3-B-T	24.0	5.2	13.5	30.1	0.47	8.21	8.47	1.25	-0.27	0.78
CCHS3-B-B	9.0	10.8	9.5	38.4	0.84	7.73	8.13	1.32	-0.11	-0.19
CCHS3-C-T	12.0	11.6	19.5	36.0	0.59	9.06	8.33	1.40	-0.30	0.15
CCHS3-C-B	8.0	14.0	14.5	40.9	0.58	8.22	8.37	1.30	-0.27	0.24
CCHS3-D-T	9.0	10.4	6.0	49.5	0.41	8.63	8.43	1.45	-0.48	0.90
CCHS3-D-B	9.0	7.6	2.0	53.1	0.43	8.52	8.42	1.26	-0.42	1.18
CCHS3-E-T	8.0	16.0	11.5	39.5	1.15	7.73	7.77	1.45	-0.21	0.05
CCHS3-E-B	2.0	34.4	6.0	51.1	1.21	7.66	7.75	1.41	-0.22	0.14
CCHS3-F-T	19.0	8.4	14.0	26.9	0.71	8.17	8.15	1.44	-0.27	-0.01
CCHS3-F-B	15.0	10.0	7.0	27.8	0.91	8.04	7.98	1.41	-0.22	0.10
CCHS3-G-T	33.0	5.2	22.5	18.7	1.05	7.72	7.87	1.49	-0.15	-0.36
CCHS3-G-B	24.0	7.6	9.0	22.0	1.38	7.63	7.59	1.54	-0.20	-0.06
CCHS3-H-T	26.0	5.2	ND	42.0	0.69	8.06	8.21	1.41	-0.31	0.41
CCHS3-H-B	13.0	16.8	10.0	60.3	1.48	7.57	7.65	1.38	-0.18	0.35
CCHS3-I-T	5.0	12.8	4.5	95.6	0.62	8.18	8.25	1.28	-0.33	0.86
CCHS3-I-B	1.0	21.2	4.5	132.4	0.39	8.61	8.59	1.11	-0.26	0.69
CCHS3-J-T	6.0	13.6	12.0	86.1	0.58	7.74	8.37	1.21	-0.29	0.86
CCHS3-J-B	3.0	21.2	6.5	66.3	0.87	7.66	8.14	1.20	-0.12	0.23
CCHS3-K-T	31.0	7.3	3.5	28.9	0.85	8.02	7.96	1.51	-0.35	0.45
CCHS3-K-B	26.0	4.8	6.0	47.4	0.66	8.06	8.24	1.34	-0.31	0.72
CCHS3-L-T	29.0	5.6	10.7	30.1	0.77	8.08	8.02	1.54	-0.36	0.32
CCHS3-L-B	6.0	15.6	5.5	48.3	1.11	7.67	7.92	1.22	-0.13	0.37
CCHS3-M-T	23.0	5.6	4.0	65.3	0.95	7.75	7.94	1.42	-0.27	0.31
CCHS3-M-B	7.0	12.8	3.5	63.2	1.64	7.59	7.51	1.44	-0.16	-0.11
CCHS3-N-T	25.0	4.7	9.0	51.4	0.83	7.70	8.08	1.44	-0.26	0.29
CCHS3-N-B	12.0	18.6	3.0	56.4	1.57	7.64	7.38	1.66	-0.10	-0.68
CCHS3-O-T	10.0	11.2	7.5	50.0	0.80	8.01	8.12	1.38	-0.25	0.24
CCHS3-O-B	0.5	77.2	7.5	105.0	1.87	7.52	7.44	1.37	-0.12	-0.16

Table 4. January 24, 1979 Survey (CCHS4)

SAMPLE	LAT	LONG	DEP	PH	TEMP	SAL	SIG T
	1	2	3	4	5	6	7
CCHS4-A	27.85055	97.44055	0.0	ND	11.0	ND	ND
CCHS4-B-T	27.83777	97.35722	0.0	7.402	9.5	27.222	21.00
CCHS4-B-B	27.83777	97.35722	1.0	7.139	9.5	27.097	20.90
CCHS4-C-T	27.78722	97.36027	0.0	7.583	11.0	28.154	21.48
CCHS4-C-B	27.78722	97.36027	2.5	7.478	11.5	28.150	21.40
CCHS4-D-T	27.74583	97.34111	0.0	7.026	11.5	28.145	21.39
CCHS4-D-B	27.74583	97.34111	3.5	7.263	11.5	28.152	21.40
CCHS4-E-T	27.81000	97.30055	0.0	7.642	11.0	28.093	21.43
CCHS4-E-B	27.81000	97.30055	12.0	6.952	13.5	30.499	22.84
CCHS4-F-T	27.85194	97.28333	0.0	7.135	11.5	27.717	21.07
CCHS4-F-B	27.85194	97.28333	3.0	7.775	11.5	27.706	21.08
CCHS4-G-T	27.80416	97.23750	0.0	7.006	11.5	28.409	21.60
CCHS4-G-B	27.80416	97.23750	3.5	6.630	11.5	28.382	21.57
CCHS4-H-T	27.76250	97.26444	0.0	7.009	11.0	28.493	21.75
CCHS4-H-B	27.76250	97.26444	3.5	6.883	11.5	28.494	21.67
CCHS4-I-T	27.72250	97.28277	0.0	7.514	11.0	28.182	21.50
CCHS4-I-B	27.72250	97.28277	3.5	7.366	11.5	28.169	21.41
CCHS4-J-T	27.70027	97.22111	0.0	7.723	12.0	28.248	21.38
CCHS4-J-B	27.70027	97.22111	3.5	7.119	12.0	28.249	21.38
CCHS4-K-T	27.75583	97.19666	0.0	5.788	11.5	28.001	21.28
CCHS4-K-B	27.75583	97.19666	3.0	8.112	11.5	28.000	21.28
CCHS4-L-T	27.79222	97.15472	0.0	7.469	12.0	28.646	21.70
CCHS4-L-B	27.79222	97.15472	2.0	7.398	12.0	28.648	21.70
CCHS4-M-T	27.82305	97.16972	0.0	7.154	12.0	28.581	21.64
CCHS4-M-B	27.82305	97.16972	14.0	6.988	12.0	30.126	22.82
CCHS4-N-T	27.83527	97.10361	0.0	6.706	12.0	23.299	17.57
CCHS4-N-B	27.83527	97.10361	14.0	5.575	12.0	29.045	22.00
CCHS4-O-T	27.83888	97.04916	0.0	5.081	12.0	24.457	18.47
CCHS4-O-B	27.83888	97.04916	13.0	6.946	14.5	33.879	25.24

Table 4. January 24, 1979 Survey (CCHS4)--Continued

	TRANS	MASS	%ORG	PC	S/CL	MODE	MEAN	STDV	SKEW	KURT
	8	9	10	11	12	13	14	15	16	17
CCHS4-A	2.0	31.6	1.0	52.7	0.31	8.59	8.57	1.00	-0.36	1.65
CCHS4-B-T	16.0	19.2	30.1	41.6	0.45	9.08	8.49	1.44	-0.38	0.35
CCHS4-B-B	12.0	20.4	ND	39.6	0.52	8.14	8.37	1.28	-0.29	0.69
CCHS4-C-T	2.0	42.8	43.0	54.2	0.69	9.05	8.20	1.38	-0.22	-0.27
CCHS4-C-B	1.0	40.8	49.5	62.1	0.71	9.02	8.19	1.32	-0.18	-0.42
CCHS4-D-T	2.0	39.2	72.5	64.4	0.88	8.10	7.98	1.29	-0.12	-0.34
CCHS4-D-B	2.0	36.8	81.5	59.9	0.96	8.14	7.85	1.46	-0.18	-0.29
CCHS4-E-T	2.0	43.6	61.0	68.8	0.83	8.09	8.08	1.40	-0.15	-0.47
CCHS4-E-B	3.0	48.0	68.5	46.9	1.31	7.71	7.77	1.22	-0.04	-0.16
CCHS4-F-T	4.0	82.8	77.0	56.1	0.94	8.10	7.90	1.46	-0.18	-0.26
CCHS4-F-B	2.5	32.8	78.5	58.9	1.13	8.07	7.81	1.40	-0.05	-0.58
CCHS4-G-T	4.0	34.4	78.5	54.8	0.98	8.01	7.86	1.55	-0.18	-0.38
CCHS4-G-B	2.5	34.4	78.0	39.5	1.18	6.16	7.63	1.64	-0.15	-0.52
CCHS4-H-T	4.0	34.4	77.5	38.7	1.05	8.02	7.89	1.26	-0.12	-0.06
CCHS4-H-B	2.0	32.4	83.5	56.2	1.17	8.03	7.67	1.54	-0.22	-0.18
CCHS4-I-T	3.0	37.6	80.0	65.7	1.00	8.02	7.92	1.33	-0.14	-0.05
CCHS4-I-B	1.5	45.6	79.5	60.3	0.79	8.07	8.13	1.30	-0.13	-0.30
CCHS4-J-T	1.5	51.6	87.0	101.3	0.72	8.16	8.14	1.35	-0.19	-0.15
CCHS4-J-B	0.5	50.4	76.5	116.3	0.81	8.17	7.97	1.20	-0.32	-0.43
CCHS4-K-T	3.5	10.8	75.0	89.5	1.08	8.06	7.85	1.40	-0.06	-0.49
CCHS4-K-B	2.0	34.8	93.0	64.5	0.88	8.10	8.02	1.36	-0.10	-0.40
CCHS4-L-T	6.5	25.2	87.0	80.1	1.14	8.02	7.75	1.52	-0.13	-0.37
CCHS4-L-B	6.0	26.8	84.0	73.4	1.05	8.07	7.86	1.46	-0.07	-0.55
CCHS4-M-T	3.0	36.8	91.5	60.3	1.19	8.12	7.70	1.52	-0.06	-0.75
CCHS4-M-B	1.5	30.0	60.5	49.5	1.13	8.10	7.74	1.46	-0.13	-0.39
CCHS4-N-T	7.0	46.4	84.5	60.4	0.97	8.16	7.90	1.55	-0.13	-0.54
CCHS4-N-B	2.5	36.8	78.0	61.5	1.21	8.04	7.70	1.46	-0.12	-0.40
CCHS4-O-T	8.0	21.2	91.5	44.2	0.99	8.14	7.73	1.72	-0.20	-0.47
CCHS4-O-B	0.0	111.2	5.0	78.9	1.13	8.08	7.69	1.53	-0.22	-0.35

Table 5. May 31, 1979 Survey (CCHS5)

SAMPLE	LAT	LONG	DEP	PH	TEMP	SAL	SIG T
	1	2	3	4	5	6	7
CCHS5-A	27.85055	97.44055	0.0	8.078	26.5	15.504	8.31
CCHS5-B-T	27.83777	97.35722	0.0	8.246	27.0	21.226	12.40
CCHS5-B-B	27.83777	97.35722	1.5	8.278	27.5	21.549	12.51
CCHS5-C-T	27.78722	97.36027	0.0	8.230	27.0	23.357	14.01
CCHS5-C-B	27.78722	97.36027	2.5	8.251	27.0	23.365	14.02
CCHS5-D-T	27.74583	97.34111	0.0	8.273	27.0	23.392	14.04
CCHS5-D-B	27.74583	97.34111	3.5	ND	27.0	ND	ND
CCHS5-E-T	27.81000	97.30055	0.0	8.316	27.0	24.324	14.74
CCHS5-E-B	27.81000	97.30055	12.0	8.151	26.0	27.336	17.30
CCHS5-F-T	27.85194	97.28333	0.0	8.337	27.0	24.406	14.80
CCHS5-F-B	27.85194	97.28333	3.0	8.323	27.0	24.508	14.87
CCHS5-G-T	27.80416	97.23750	0.0	8.416	27.0	25.861	15.88
CCHS5-G-B	27.80416	97.23750	3.5	8.338	26.5	26.858	16.78
CCHS5-H-T	27.76250	97.26444	0.0	8.452	27.0	25.382	15.53
CCHS5-H-B	27.76250	97.26444	4.0	8.441	27.0	25.960	15.96
CCHS5-I-T	27.72250	97.28277	0.0	8.440	27.5	27.374	16.86
CCHS5-I-B	27.72250	97.28277	3.5	8.501	27.0	29.604	18.68
CCHS5-J-T	27.70027	97.22111	0.0	8.516	27.0	28.767	18.06
CCHS5-J-B	27.70027	97.22111	3.5	8.500	27.0	29.539	18.64
CCHS5-K-T	27.75583	97.19666	0.0	8.450	27.0	25.405	15.54
CCHS5-K-B	27.75583	97.19666	3.5	8.397	27.0	26.103	16.06
CCHS5-L-T	27.79222	97.15472	0.0	8.425	27.0	26.160	16.11
CCHS5-L-B	27.79222	97.15472	2.5	8.393	27.0	26.718	16.52
CCHS5-M-T	27.82305	97.16972	0.0	8.415	28.0	27.013	16.43
CCHS5-M-B	27.82305	97.16972	14.0	8.219	25.0	30.149	19.70
CCHS5-N-T	27.83527	97.10361	0.0	8.254	26.0	29.823	19.15
CCHS5-N-B	27.83527	97.10361	15.0	8.233	25.5	29.872	19.34
CCHS5-O-T	27.83888	97.04916	0.0	8.266	26.5	29.069	18.43
CCHS5-O-B	27.83888	97.04916	13.0	8.229	25.0	29.874	19.49

Table 5. May 31, 1979 Survey (CCHS5)--Continued

	TRANS	MASS	%ORG	PC	S/CL	MODE	MEAN	STDV	SKEW	KURT
	8	9	10	11	12	13	14	15	16	17
CCHS5-A	1.0	73.6	0.0	161.0	0.13	9.59	9.24	1.12	-0.66	3.04
CCHS5-B-T	2.0	33.2	4.5	82.1	0.55	9.24	8.44	1.63	-0.40	0.28
CCHS5-B-B	0.0	41.6	9.0	96.5	0.63	7.66	8.36	1.35	-0.34	0.61
CCHS5-C-T	0.5	45.6	0.0	142.4	0.52	9.24	8.46	1.43	-0.35	0.30
CCHS5-C-B	0.0	86.4	1.5	222.6	0.42	9.17	8.64	1.17	-0.22	-0.07
CCHS5-D-T	3.0	46.0	1.5	116.4	0.52	9.15	8.41	1.42	-0.41	0.52
CCHS5-D-B	0.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
CCHS5-E-T	2.0	43.6	7.5	83.0	0.44	10.10	8.69	1.64	-0.41	0.07
CCHS5-E-B	0.0	173.6	2.5	383.2	0.56	9.16	8.40	1.48	-0.33	0.07
CCHS5-F-T	1.5	26.4	4.5	75.0	0.55	9.10	8.45	1.41	-0.26	-0.07
CCHS5-F-B	1.0	30.8	1.5	81.0	0.61	9.02	8.28	1.25	-0.34	0.66
CCHS5-G-T	2.5	24.4	1.0	73.6	0.57	8.63	8.23	1.38	-0.40	0.52
CCHS5-G-B	0.0	71.6	1.0	136.2	0.67	9.55	8.20	1.72	-0.28	-0.55
CCHS5-H-T	3.0	22.0	2.5	59.9	0.56	8.13	8.45	1.53	-0.26	0.02
CCHS5-H-B	0.5	63.2	4.5	74.7	0.39	9.03	8.54	1.39	-0.58	2.26
CCHS5-I-T	4.5	22.8	2.5	65.0	0.56	8.19	8.24	1.60	-0.44	0.66
CCHS5-I-B	3.0	28.8	9.0	66.3	0.71	8.10	8.05	1.53	-0.42	0.63
CCHS5-J-T	17.0	4.0	1.5	42.8	0.71	8.18	7.90	1.87	-0.31	-0.60
CCHS5-J-B	14.5	11.6	12.5	44.8	0.85	8.12	7.78	1.79	-0.28	-0.49
CCHS5-K-T	5.0	15.6	4.0	51.9	0.64	8.14	8.18	1.57	-0.40	0.44
CCHS5-K-B	0.0	130.4	3.0	161.6	0.81	8.00	7.94	1.68	-0.38	0.23
CCHS5-L-T	7.5	12.0	9.0	63.6	0.65	8.25	7.95	1.90	-0.36	-0.51
CCHS5-L-B	0.5	17.6	5.5	63.0	0.83	8.13	7.79	1.81	-0.29	-0.55
CCHS5-M-T	13.0	9.2	12.0	41.2	0.69	8.14	8.12	1.63	-0.34	-0.05
CCHS5-M-B	0.0	35.2	4.0	33.1	0.69	10.11	8.35	1.73	-0.24	-0.52
CCHS5-N-T	11.0	12.4	8.0	24.8	0.77	8.05	8.15	1.56	-0.21	-0.14
CCHS5-N-B	1.5	61.2	6.5	26.6	1.87	7.61	7.31	1.59	-0.16	-0.54
CCHS5-O-T	4.0	24.8	12.5	34.9	1.07	8.04	7.77	1.47	-0.26	-0.06
CCHS5-O-B	0.0	65.6	20.5	48.9	1.42	7.71	7.42	1.65	-0.21	-0.47

Table 6. August 8, 1979 Survey (CCHS6)

SAMPLE	LAT	LONG	DEP	PH	TEMP	SAL	SIG T
	1	2	3	4	5	6	7
CCHS6-A	27.85055	97.44055	0.0	7.917	31.0	13.602	5.50
CCHS6-B-T	27.83777	97.35722	0.0	8.125	30.7	24.826	13.92
CCHS6-B-B	27.83777	97.35722	2.0	7.894	30.4	24.732	13.95
CCHS6-C-T	27.78722	97.36027	0.0	8.174	31.0	24.551	13.62
CCHS6-C-B	27.78722	97.36027	2.5	8.096	31.0	24.546	13.61
CCHS6-D-T	27.74583	97.34111	0.0	8.008	31.0	25.075	14.01
CCHS6-D-B	27.74583	97.34111	3.5	7.944	31.0	25.209	14.10
CCHS6-E-T	27.81000	97.30055	0.0	8.339	31.0	26.126	14.78
CCHS6-E-B	27.81000	97.30055	14.0	8.219	30.0	32.572	19.93
CCHS6-F-T	27.85194	97.28333	0.0	8.212	30.5	25.687	14.62
CCHS6-F-B	27.85194	97.28333	3.5	8.066	30.0	26.576	15.46
CCHS6-G-T	27.80416	97.23750	0.0	8.328	30.0	26.556	15.45
CCHS6-G-B	27.80416	97.23750	4.0	8.355	30.0	30.450	18.34
CCHS6-H-T	27.76250	97.26444	0.0	8.252	30.5	26.187	15.00
CCHS6-H-B	27.76250	97.26444	4.0	8.073	30.0	27.983	16.51
CCHS6-I-T	27.72250	97.28277	0.0	8.262	30.5	25.629	14.59
CCHS6-I-B	27.72250	97.28277	4.0	8.183	30.0	26.248	15.22
CCHS6-J-T	27.70027	97.22111	0.0	8.231	31.0	26.877	15.34
CCHS6-J-B	27.70027	97.22111	4.0	6.655	30.0	27.080	15.84
CCHS6-K-T	27.75583	97.19666	0.0	7.861	30.5	26.576	15.30
CCHS6-K-B	27.75583	97.19666	4.0	8.067	30.0	27.174	15.91
CCHS6-L-T	27.79222	97.15472	0.0	9.426	31.0	27.592	15.88
CCHS6-L-B	27.79222	97.15472	3.0	8.374	30.0	28.571	16.94
CCHS6-M-T	27.82305	97.16972	0.0	8.197	31.5	31.447	18.57
CCHS6-M-B	27.82305	97.16972	13.0	8.091	30.5	32.969	20.06
CCHS6-N-T	27.83527	97.10361	0.0	8.198	30.0	32.831	20.12
CCHS6-N-B	27.83527	97.10361	15.0	8.146	30.5	33.314	20.31
CCHS6-O-T	27.83888	97.04916	0.0	8.050	31.0	29.883	17.58
CCHS6-O-B	27.83888	97.04916	13.0	8.054	30.0	33.412	20.56

Table 6. August 8, 1979 Survey (CCHS6)--Continued

SAMPLE	TRANS	MASS	%ORG	PC	S/CL	MODE	MEAN	STDV	SKEW	KURT
	8	9	10	11	12	13	14	15	16	17
CCHS6-A	1.5	41.6	ND	158.5	0.26	8.68	8.77	1.04	-0.26	0.78
CCHS6-B-T	5.0	18.4	ND	33.1	0.69	8.11	8.00	1.22	-0.32	1.13
CCHS6-B-B	3.0	20.0	ND	42.2	0.80	8.11	7.96	1.25	-0.23	0.74
CCHS6-C-T	1.0	18.0	ND	38.2	0.84	8.09	7.89	1.38	-0.35	0.90
CCHS6-C-B	0.0	27.6	ND	46.5	0.92	8.07	7.96	1.19	-0.18	0.60
CCHS6-D-T	6.0	14.8	ND	32.4	0.86	8.08	7.95	1.25	-0.31	1.12
CCHS6-D-B	0.0	16.8	ND	38.6	0.55	8.11	8.27	1.12	-0.25	1.57
CCHS6-E-T	4.5	14.4	ND	35.3	0.62	8.11	8.15	1.19	-0.29	1.37
CCHS6-E-B	0.0	106.4	ND	129.6	0.71	8.08	8.19	1.13	-0.16	0.28
CCHS6-F-T	3.5	18.0	ND	39.2	0.61	8.10	8.16	1.10	-0.28	1.74
CCHS6-F-B	0.0	30.8	ND	68.0	0.49	8.11	8.34	1.04	-0.19	1.42
CCHS6-G-T	13.0	9.6	ND	29.3	0.74	8.11	8.02	1.26	-0.25	0.82
CCHS6-G-B	2.0	27.6	ND	59.6	1.26	8.07	7.64	1.45	-0.18	-0.16
CCHS6-H-T	15.0	5.6	ND	20.9	0.79	8.10	7.92	1.23	-0.38	1.67
CCHS6-H-B	4.0	30.8	ND	52.2	0.83	8.08	7.99	1.20	-0.31	1.48
CCHS6-I-T	6.0	13.6	ND	33.4	0.88	8.09	7.85	1.36	-0.38	1.09
CCHS6-I-B	0.0	34.8	ND	59.6	0.99	8.07	7.80	1.48	-0.32	0.45
CCHS6-J-T	13.0	10.4	ND	31.6	1.04	8.08	7.80	1.43	-0.25	0.55
CCHS6-J-B	3.0	12.8	ND	39.4	0.89	8.08	8.02	1.24	-0.14	1.00
CCHS6-K-T	14.0	6.8	ND	28.7	0.92	8.08	7.94	1.31	-0.19	0.86
CCHS6-K-B	0.0	18.0	ND	39.9	0.91	8.08	7.91	1.27	-0.36	1.50
CCHS6-L-T	13.0	2.0	ND	24.7	0.76	8.10	8.01	1.12	-0.14	1.12
CCHS6-L-B	7.0	8.0	ND	31.2	0.85	8.10	7.93	1.21	-0.22	1.12
CCHS6-M-T	7.0	16.0	ND	39.7	1.10	8.05	7.87	1.21	-0.06	0.04
CCHS6-M-B	0.0	5.2	ND	12.6	1.47	7.64	7.67	1.40	-0.05	-0.12
CCHS6-N-T	52.0	2.8	ND	11.0	1.17	7.61	7.88	1.53	-0.14	-0.25
CCHS6-N-B	44.0	5.2	ND	10.9	1.59	7.61	7.52	1.57	-0.10	-0.25
CCHS6-O-T	74.0	0.4	ND	7.4	1.82	4.11	6.59	2.28	0.16	-1.29
CCHS6-O-B	29.0	10.8	ND	15.3	2.20	7.22	7.34	1.42	-0.00	-0.18

Table 7. October 3, 1979 Survey (CCHS7)

SAMPLE	LAT	LONG	DEP	PH	TEMP	SAL	SIG T
	1	2	3	4	5	6	7
CCHS7-A	27.85055	97.44055	0.0	7.316	27.5	18.001	9.86
CCHS7-B-T	27.83777	97.35722	0.0	7.840	27.0	22.143	13.11
CCHS7-B-B	27.83777	97.35722	2.0	7.877	27.0	22.103	13.08
CCHS7-C-T	27.78722	97.36027	0.0	8.073	27.0	22.456	13.33
CCHS7-C-B	27.78722	97.36027	3.0	7.650	27.0	22.461	13.34
CCHS7-D-T	27.74583	97.34111	0.0	7.597	27.0	22.682	13.51
CCHS7-D-B	27.74583	97.34111	3.5	7.648	26.5	22.677	13.65
CCHS7-E-T	27.81000	97.30055	0.0	8.030	27.0	22.291	13.22
CCHS7-E-B	27.81000	97.30055	13.5	7.800	27.0	28.518	17.87
CCHS7-F-T	27.85194	97.28333	0.0	7.846	26.5	21.861	13.05
CCHS7-F-B	27.85194	97.28333	3.5	8.145	26.5	21.965	13.12
CCHS7-G-T	27.80416	97.23750	0.0	8.004	26.5	23.094	13.96
CCHS7-G-B	27.80416	97.23750	2.8	7.706	26.5	23.009	13.90
CCHS7-H-T	27.76250	97.26444	0.0	7.983	26.5	22.906	13.82
CCHS7-H-B	27.76250	97.26444	4.0	7.801	26.5	22.918	13.82
CCHS7-I-T	27.72250	97.28277	0.0	8.062	26.5	22.463	13.49
CCHS7-I-B	27.72250	97.28277	4.0	8.069	26.0	22.537	13.69
CCHS7-J-T	27.70027	97.22111	0.0	8.244	27.0	23.625	14.21
CCHS7-J-B	27.70027	97.22111	4.0	7.357	26.0	28.386	18.08
CCHS7-K-T	27.75583	97.19666	0.0	7.437	27.0	23.684	14.26
CCHS7-K-B	27.75583	97.19666	4.0	7.792	27.0	24.016	14.51
CCHS7-L-T	27.79222	97.15472	0.0	7.639	26.5	22.588	13.59
CCHS7-L-B	27.79222	97.15472	3.0	8.114	26.5	22.546	13.55
CCHS7-M-T	27.82035	97.16972	0.0	7.754	27.0	22.919	13.68
CCHS7-M-B	27.82035	97.16972	14.0	7.362	26.5	31.704	20.42
CCHS7-N-T	27.83527	97.10361	0.0	7.574	26.5	22.912	13.82
CCHS7-N-B	27.83527	97.10361	14.0	7.430	26.5	23.720	14.43
CCHS7-O-T	27.83888	97.04916	0.0	7.709	27.0	26.539	16.39
CCHS7-O-B	27.83888	97.04916	14.0	7.491	26.5	34.285	22.35

Table 7. October 3, 1979 Survey (CCHS7)--Continued

	TRANS	MASS	%ORG	PC	S/CL	MODE	MEAN	STDV	SKEW	KURT
	8	9	10	11	12	13	14	15	16	17
CCHS7-A	2.0	77.6	ND	125.9	0.45	8.63	8.50	1.35	-0.36	0.64
CCHS7-B-T	2.0	38.4	ND	49.4	1.12	7.66	7.95	1.26	0.02	-0.30
CCHS7-B-B	0.0	40.4	ND	61.2	1.30	7.63	7.84	1.28	0.02	-0.25
CCHS7-C-T	13.0	15.2	ND	33.8	1.09	7.63	7.98	1.42	-0.10	-0.07
CCHS7-C-B	7.0	10.8	ND	33.1	1.02	7.65	8.03	1.37	-0.09	-0.06
CCHS7-D-T	10.0	18.4	ND	45.2	0.76	7.71	8.22	1.29	-0.20	0.46
CCHS7-D-B	1.0	24.8	ND	45.3	0.74	7.71	8.25	1.27	-0.16	0.32
CCHS7-E-T	10.0	48.0	ND	40.0	0.86	7.68	8.12	1.38	-0.18	0.08
CCHS7-E-B	0.0	89.2	ND	47.6	0.92	7.71	8.09	1.22	-0.03	-0.34
CCHS7-F-T	6.5	21.6	ND	61.1	0.80	8.00	8.12	1.39	-0.22	0.17
CCHS7-F-B	1.0	60.0	ND	69.6	0.77	8.08	8.11	1.38	-0.28	0.48
CCHS7-G-T	3.0	50.8	ND	60.6	1.31	7.62	7.71	1.40	-0.23	0.40
CCHS7-G-B	0.0	69.2	ND	72.0	1.35	7.67	7.57	1.55	-0.21	-0.32
CCHS7-H-T	6.5	25.2	ND	54.0	1.12	7.71	7.70	1.62	-0.23	-0.35
CCHS7-H-B	1.0	27.2	ND	38.3	0.67	7.75	8.31	1.18	-0.18	0.87
CCHS7-I-T	13.0	18.8	ND	44.9	0.92	8.09	7.82	1.65	-0.24	-0.39
CCHS7-I-B	0.5	27.6	ND	39.8	0.94	7.69	8.05	1.30	-0.19	0.49
CCHS7-J-T	0.5	22.4	ND	28.6	1.28	7.64	7.58	1.87	-0.13	-0.75
CCHS7-J-B	0.0	45.2	ND	111.3	1.74	7.60	7.46	1.46	-0.15	-0.11
CCHS7-K-T	6.0	24.0	ND	41.4	1.46	7.66	7.38	1.80	-0.15	-0.68
CCHS7-K-B	0.0	52.8	ND	58.4	1.72	7.63	7.38	1.59	-0.14	-0.45
CCHS7-L-T	5.5	28.0	ND	49.8	1.28	7.74	7.38	1.87	-0.15	-0.89
CCHS7-L-B	2.0	36.8	ND	56.6	1.57	8.02	7.11	1.90	-0.03	-1.11
CCHS7-M-T	6.0	46.8	ND	63.8	1.97	5.12	6.97	1.78	-0.01	-1.00
CCHS7-M-B	1.5	57.6	ND	72.9	2.87	5.06	6.80	1.61	0.06	-0.90
CCHS7-N-T	1.0	21.6	ND	32.1	1.64	7.66	7.27	1.82	-0.04	-0.91
CCHS7-N-B	0.0	17.2	ND	15.5	3.10	4.64	6.40	1.83	0.23	-0.96
CCHS7-O-T	32.0	11.2	ND	25.0	2.03	4.62	6.82	1.96	0.08	-1.20
CCHS7-O-B	11.0	28.4	ND	18.0	3.25	4.68	6.43	1.74	0.17	-1.06

Table 8. April 23, 1980 Survey (CCHS8)

SAMPLE	LAT	LONG	DEP	PH	TEMP	SAL	SIG T
	1	2	3	4	5	6	7
CCHS8-A	27.85055	97.44055	0.0	7.910	20.0	30.787	21.58
CCHS8-B-T	27.83777	97.35722	0.0	8.160	20.5	29.693	20.62
CCHS8-B-B	27.83777	97.35722	2.5	8.228	20.5	29.689	20.61
CCHS8-C-T	27.78722	97.36027	0.0	8.175	20.5	30.221	21.02
CCHS8-C-B	27.78722	97.36027	3.0	8.145	20.5	30.209	21.01
CCHS8-D-T	27.74583	97.34111	0.0	8.255	20.5	30.302	21.08
CCHS8-D-B	27.74583	97.34111	3.5	8.265	20.5	30.344	21.11
CCHS8-E-T	27.81000	97.30055	0.0	8.167	20.5	29.310	20.33
CCHS8-E-B	27.81000	97.30055	13.0	8.041	19.5	32.765	23.20
CCHS8-F-T	27.85194	97.28333	0.0	8.107	20.5	30.157	20.97
CCHS8-F-B	27.85194	97.28333	3.0	8.132	20.5	30.211	21.01
CCHS8-G-T	27.80416	97.23750	0.0	8.160	20.0	30.895	21.66
CCHS8-G-B	27.80416	97.23750	4.0	8.148	20.0	30.920	21.68
CCHS8-H-T	27.76250	97.26444	0.0	8.195	20.5	30.504	21.24
CCHS8-H-B	27.76250	97.26444	3.5	8.175	20.0	30.566	21.41
CCHS8-I-T	27.72250	97.28277	0.0	8.235	20.5	30.386	21.14
CCHS8-I-B	27.72250	97.28277	3.5	8.210	20.5	30.358	21.12
CCHS8-J-T	27.70027	97.22111	0.0	8.211	21.0	29.605	20.43
CCHS8-J-B	27.70027	97.22111	3.5	8.220	21.0	29.639	20.45
CCHS8-K-T	27.75583	97.19666	0.0	8.172	21.0	30.178	20.86
CCHS8-K-B	27.75583	97.19666	3.5	8.213	21.0	30.224	20.90
CCHS8-L-T	27.79222	97.15472	0.0	8.172	21.0	30.019	20.73
CCHS8-L-B	27.79222	97.15472	3.0	8.161	21.0	30.038	20.75
CCHS8-M-B	27.82035	97.16972	13.0	8.136	20.0	32.718	23.04
CCHS8-N-T	27.83527	97.10361	0.0	8.149	20.0	34.330	24.25
CCHS8-N-B	27.83527	97.10361	14.0	8.152	20.0	34.434	24.35
CCHS8-O-T	27.83888	97.04916	0.0	8.159	20.0	34.559	24.44
CCHS8-O-B	27.83888	97.04916	11.0	8.153	20.0	34.565	24.45

Table 8. April 23, 1980 Survey (CCHS8)--Continued

	TRANS	MASS	%ORG	PC	S/CL	MODE	MEAN	STDV	SKEW	KURT
	8	9	10	11	12	13	14	15	16	17
CCHS8-A	0.0	332.8	ND	489.4	0.39	9.11	8.48	1.40	-0.52	0.99
CCHS8-B-T	3.5	109.6	ND	123.7	0.70	8.15	8.19	1.24	-0.23	0.06
CCHS8-B-B	0.0	111.6	ND	92.4	0.68	8.14	8.22	1.16	-0.22	0.26
CCHS8-C-T	4.0	46.4	ND	56.8	1.33	8.14	7.51	1.60	-0.06	-0.97
CCHS8-C-B	0.0	44.8	ND	35.1	1.41	8.10	7.49	1.50	-0.08	-0.71
CCHS8-D-T	1.5	42.4	ND	35.5	0.94	8.06	7.98	1.24	-0.18	0.46
CCHS8-D-B	0.0	48.4	ND	37.3	1.34	8.04	7.66	1.36	-0.11	-0.33
CCHS8-E-T	1.5	46.0	ND	83.3	0.56	9.00	8.30	1.32	-0.36	0.63
CCHS8-E-B	0.0	50.0	ND	54.4	0.56	8.24	8.27	1.15	-0.33	0.84
CCHS8-F-T	2.0	50.4	ND	39.8	0.59	8.22	8.18	1.33	-0.37	0.45
CCHS8-F-B	0.5	39.6	ND	37.8	0.65	8.22	8.14	1.37	-0.31	0.09
CCHS8-G-T	2.0	34.4	ND	32.7	0.94	8.11	7.84	1.51	-0.27	-0.17
CCHS8-G-B	0.0	41.2	ND	28.1	1.12	8.06	7.70	1.44	-0.23	-0.20
CCHS8-H-T	3.0	21.6	ND	39.4	0.95	8.04	7.95	1.28	-0.21	0.34
CCHS8-H-B	0.0	53.6	ND	40.1	1.15	8.00	7.86	1.21	-0.11	0.04
CCHS8-I-T	1.5	41.6	ND	36.4	1.50	7.62	7.72	1.19	-0.01	0.00
CCHS8-I-B	0.0	35.2	ND	35.7	1.17	7.67	7.91	1.15	-0.07	0.41
CCHS8-J-T	6.5	17.6	ND	31.6	1.24	7.71	7.78	1.38	-0.10	-0.17
CCHS8-J-B	3.5	22.0	ND	28.2	1.16	7.71	7.88	1.24	-0.08	0.20
CCHS8-K-T	6.0	10.8	ND	31.9	0.90	8.06	8.00	1.32	-0.20	0.18
CCHS8-K-B	1.0	44.4	ND	34.8	1.19	7.69	7.85	1.28	-0.09	0.06
CCHS8-L-T	17.0	11.2	ND	24.3	1.25	7.72	7.74	1.50	-0.10	-0.31
CCHS8-L-B	4.0	21.2	ND	32.1	1.48	7.63	7.62	1.40	-0.08	-0.19
CCHS8-M-T	15.5	12.4	ND	16.4	1.17	8.06	7.77	1.36	-0.11	-0.26
CCHS8-M-B	11.0	23.6	ND	23.5	1.16	8.10	7.40	1.80	-0.24	-0.72
CCHS8-N-T	8.5	13.2	ND	22.3	1.46	7.68	7.62	1.36	-0.10	-0.22
CCHS8-N-B	4.0	40.4	ND	24.3	2.22	7.22	7.33	1.31	-0.02	-0.25
CCHS8-O-T	8.0	25.6	ND	22.8	1.12	8.03	7.84	1.30	-0.13	-0.13
CCHS8-O-B	3.0	104.4	ND	23.4	1.62	7.65	7.52	1.39	-0.10	-0.22

ACKNOWLEDGMENTS

The authors acknowledge their gratitude to personnel of the U.S. Coast Guard Station in Corpus Christi for providing helicopter support. Gratitude is also expressed to the several U.S. Geological Survey staff members of the Corpus Christi office who provided assistance in field work and laboratory analyses.

REFERENCES CITED

Allen, T., 1968, The Coulter Counter, In Particle Size Measurement: London, Chapman & Hall, LTD, p. 143-153.

Behrens, E. W., 1978, Further comparisons of grain size distributions determined by electronic particle counting and pipette techniques: Journal of Sedimentary Petrology, v. 48, p. 1213-1218.

Coulter Electronics, 1975, Operators Manual for Coulter Counter Model TAII: Hialeah, Fla., Coulter Electronics, Inc., 117 p.

Coulter, H. W., 1956, High speed automatic bloodcell counter and cell size analyzer: National Elec. Conference Proceedings 12, p. 1034-1042.

Inter-agency Committee on Water Resources, 1964, Electronic sensing of sediments: Minneapolis, St. Anthony Falls Hydraulic Laboratory, Report R., 80 p.

Krumbein, W. C., 1934, Size frequency distributions of sediments: Journal of Sedimentary Petrology, v. 4, p. 65-77.

McCave, I. N., and Jarvis, J., 1973, Use of the Model T Coulter Counter in size analysis of fine to coarse sand: Sedimentology, v. 20, p. 305-315.

Schubel, J. R., 1971, The classification of estuaries, In Schubel, J. R. (Conv.), The Estuarine Environment - Estuaries and Estuarine Sedimentation: American Geological Institute Short Course Lecture Notes, p. II-1-8.

Sheldon, R. W., and Parsons, T. R., 1967, A Practical Manual on the Use of the Coulter Counter in Marine Research: Toronto, Coulter Electronics Sales Co., 66 p.

Shideler, G. L., 1976, A comparison of electronic particle counting and pipette techniques in routine mud analysis: Journal of Sedimentary Petrology, v. 46, p. 1017-1025.

_____1980, Reconnaissance observations of some factors influencing the turbidity structure of a restricted estuary: Corpus Christi Bay, Texas: Texas Journal of Science, v. 32, no. 1, p. 59-71.

Shideler, G. L., Stelting, C. E., and McGowen, J. H., 1981, Maps showing textural characteristics of benthic sediments in the Corpus Christi Bay estuarine system, south Texas: U.S. Geological Survey Miscellaneous Field Studies Map MF-1275.

Swift, D. J. P., Schubel, J. R., and Sheldon, R. W., 1972, Size analysis of fine-grained suspended sediments: a review: Journal of Sedimentary Petrology, v. 42, p. 122-134.

Walker, P. H., and Hutka, J., 1971, Use of the Coulter Counter (Model B) for particle-size analysis of soils: Australia Commonwealth Sci. and Ind. Research Organization, Soils Div., Tech. Paper 1, 39 p.

Walker, P. H., Woodyer, D. D., and Hutka, J., 1974, Particle size measurements by Coulter Counter of very small deposits and low suspended sediment concentrations in streams: Journal of Sedimentary Petrology, v. 44, p. 673-679.