WATER QUALITY MONITORING:
KANEOHE BAY AND SELECTED WATERSHEDS
JULY TO DECEMBER 1975

Technical Report No. 98

Reginald H.F. Young
L. Stephen Lau
Stanley K. Konno
Helen H. Lee

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PROJECT FACULTY

Reginald H.F. Young, Principal Investigator
L. Stephen Lau
Eriks Leitus

PROJECT STAFF

Stanley K. Konno
Cary K. Kondo
Helen H. Lee
Robert J. Oldnall

WATER RESOURCES RESEARCH CENTER

University of Hawaii

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ERRATA SHEET

Please note the following corrections to our Technical Report No. 98 entitled, *Water Quality Monitoring: Kaneohe Bay and Selected Watersheds, July to December 1975* (Young, Lau, Konno, and Lee).

Page		Correction
8	Table 1	Turbidity, Station 7 as 0.59 ± 0.3
	Table 1	pH, Station 9 median as 8.5, not 4.5
10	Table 3	Ortho-P, Station C mean as 0.017 ± 0.009
26	Table 13	Change title to: Pesticide and PCB Data
27	Table 14	Footnote ** as <5 ppb...and <3 ppb
28	Table 15	Mercury, Stations 1, 2, 3, 5, 9, 12 as <0.003 ± 0.000, <0.003
37	Item 14	EPA reference is 1974, not 1973
38	Item 18	EPA reference is 1974, not 1973
41	Line 2	Table 7 as Table 14 (p. 27)

ABSTRACT

A water quality monitoring survey of three drainage subareas in the Kaneohe Bay watershed and selected sites in the bay was conducted between July and December 1975 to ascertain the dry-weather quality baseline. The three drainage subareas were Kaneohe, Waihee, and Waikane. Upstream stations beyond any highly developed areas and downstream stations near the stream mouths were selected in order to obtain some information on the effect of development or land use on water quality. Bay stations were located off the stream mouths, over sewer outfalls in the southern sector, and in the main channels of the bay.

The results yielded patterns as expected: poorer quality in the more developed southern and central subareas compared to the northern subarea, poor quality also off the stream mouths and at the sewer outfalls in the bay. The stream monitoring results generally parallel previous studies by the Water Resources Research Center and the Hawaii Environmental Simulation Laboratory.

The State Water Quality Standards for Class AA (bay) and 2 (stream) waters were exceeded in the case of nutrients (N and P) and coliform bacteria, but were met in the case of pH and dissolved oxygen.

Loading rates, based on mean flow data and parametric concentrations for N and P compared against 1968 data, indicate a two-fold increase for the southern subarea, a lesser increase for the central subarea, and relatively little change for the northern subarea.

As expected, the bay water contained but a few parts per trillion of α chlordane, γ-chlordane, dieldrin, and PCP. The stream water samples were generally slightly higher in concentration. DDT, DDD, DDE, lindane, heptachlor, and PCB were not detected. The highest level, although low in parts per trillion of pesticides, was found in stream water draining developed land. Heavy metals, Cd, Cr, Cu, Pb, Hg, Ni, and Zn, were present in bay water in expectedly low background concentrations on the order of a few parts per billion. No gradation in heavy metal concentrations was observed in different parts of the bay. The heavy metal content in the streams was comparable to those in the bay.

RECOMMENDATIONS

The results of this study provide information on the dry-weather or low flow period of the year for Kaneohe Bay. Higher parametric concentrations, loadings, and greater variability in data can be expected in wet-weather or heavy runoff periods with more suspended material transported in the drainage channels into the bay. Monitoring should be continued through the wet-weather period and the study should be expanded to examine the quality factors in the sediment since previous work by others in Hawaii has indicated that heavy metals and chlorinated hydrocarbon pesticides are associated with the sediment. The pattern of quality variation in the water column during the rise and fall of flood flows or heavy runoff also needs to be ascertained.

The stream monitoring stations used in this study appear to be suitable for continued work. Bay stations utilized also are appropriate although consideration should be given to eliminating two or three from among Stations 4, 6, 8, 10, and 11, since there was little variation among the data from these control points.

Some parameters used in this dry-weather study are of little utility and should not be used in future work. Among these are color, settleable solids, methylene blue active substances, NO_2-N, (possibly NH_3-N), and orthophosphate. BOD_5 and COD could also be eliminated in favor of a total organic carbon (TOC) measurement. Monitoring of heavy metals and chlorinated hydrocarbon pesticides in the water column may be reduced greatly.

A biweekly to monthly sampling frequency should be adequate for future studies, except in wet-weather monitoring where a minimum of five to six flood flow or heavy runoff events should be followed.

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INTRODUCTION

The determination of water quality during the dry-weather flow period is an important facet of the Kaneohe Bay Urban Water Resources Study (KBUWRS). This information is planned to be utilized in the problem identification, development of preliminary alternative plans, and impact assessment for the Estuarine Protection and Restoration and the Wastewater Management components of the KBUWRS.

The Kaneohe Bay area was subdivided into three subareas: southern, central, and northern. One drainage basin from each subarea and the adjacent bay waters was selected for water quality monitoring. The rationale for the demarcation of the subareas was based on the different types and degree of land use reflected in these geographical divisions. The southern subarea is heavily urbanized and developed for residential use. The nearshore bay waters adjacent to this subarea have been subjected to sewage discharge and urban runoff. The central subarea is presently subjected to rapid land development, although relatively not as urbanized as the southern subarea. The northern subarea is nonurbanized and is in limited grazing and agricultural uses.

In the southern subarea, the Kaneohe Stream drainage basin was selected for study with stations in the tidal zone at the stream mouth, just beyond tidal influence, and farther upstream just after the point of entry into the residential area. In the central subarea, the Waihee drainage basin was selected with stations at the stream mouth, near the discharge of the Ahuimanu waste water treatment plant, and upstream at the USGS upper Waihee gaging station. In the northern subarea, the Waikane drainage basin was selected with a downstream station at the Kamehameha Highway bridge and an upstream station to monitor flow out of the forest reserve area.

Bay stations were located offshore from the mouths of the three streams cited above, at the two major sewer outfall discharges into the southern sector of the bay, and at the principal channels for water circulation through the bay. Detailed descriptions of the sampling stations are provided in a subsequent section.

Parameters for monitoring were selected to obtain a detailed characterization of water quality ranging from physical factors, such as temperature and turbidity, to organics (BOD/COD), nutrients (N and P), and possible toxicants and refractory substances (heavy metals, chlorinated hydrocarbon pesticides, and methylene blue active substances). Methods and procedures used in this study generally corresponded to those outlined in the scope of work of the contract. Field procedures are presented in the next section of this report, analytical methods are described in Appendix A, and storage and preservation procedures in Appendix B.

The research effort was divided between the Water Resources Research Center (WRRC) staff and the Pesticides Laboratory (Leahi Hospital) staff. Overall management was the responsibility of Dr. Reginald H.F. Young of the WRRC. Dr. L. Stephen Lau was the acting project manager from January 1976 to the termination of the project. The field sampling and monitoring, as well as analyses, of all parameters except for chlorinated hydrocarbons was accomplished by WRRC personnel. The latter analyses were done at the Pesticides Laboratory under the direction of Dr. Eriks Leitis with the cooperation and approval of Dr. Howard W. Klemmer.

The WRRC research team consisted of two environmental engineers, Stanley K. Konno and Cary K. Kondo, and one chemist, Robert J. Oldnall. The pesticides chemist working under Dr. Leitis was Helen H. Lee. Konno and Kondo were responsible for stream sampling and analysis of all samples for all parameters except heavy metals and chlorinated hydrocarbons; Oldnall was responsible for bay sampling and analysis of heavy metals.

Some delay was encountered in the heavy metals and chlorinated hydrocarbons analysis. For heavy metals, problems occurred with instrumentation and methodology as well as unforeseen leave requirements for the analyst. For the chlorinated hydrocarbons a delay was due to instrument failure.

At the request of the contracting officer, the scheduled December sampling was moved up one week to the last week in November during the first heavy seasonal storm. This was done in order to obtain some initial wet-weather quality data for a subsequent phase of the KBUWRS program. These data have not been incorporated into this document.

SAMPLING STATIONS

The stream, or freshwater, stations were designated with letters, A to H, and the bay stations were numbered from 1 to 12.

Station A. Located just beyond tidal influence upstream of Kaneohe Stream and reached by going down a steep embankment just

inside Waikalua Place in Kaneohe.
Coordinates: lat. 21°24'48" N long. 157°47'29" W

Station B. Located downstream of the bridge at Kuahulu Place in Kaneohe, just above Kahekili Highway at Likelike Highway. This station represented water from the northernmost tributary of Kaneohe Stream.
Coordinates: lat. 21°24'25" N long. 157°48'38" W

Station C. Located on Kamooalii Stream just downstream of the Luluku Stream junction. This station represented water from Kamooalii, Luluku, and Kuou streams. The exact location was just upstream of a residential catch basin accessible through Apukea and Anuapu streets.
Coordinates: lat. 21°23'47" N long. 157°48'23" W

Station D. Located approximately 18 m (20 yd) upstream of a USGS gaging station near the mouth of Waihee Stream; monitored flow in Waihee Stream originating in upper Waihee Valley.
Coordinates: lat. 21°27'32" N long. 157°50'26" W

Station E. First located on Kahaluu Stream approximately 90 m (a few-hundred yards) downstream of the Ahuimanu Sewage Treatment Plant and below the bridge where Kahekili Highway crosses the stream. However, beginning with the samples taken on 27 August 1975, the station was moved to a location on Kahaluu Stream just above the Kahaluu-Waihee Stream junction. This move was necessary to incorporate the flow from the portion of Kahaluu Stream originating in the mountains above the Valley of the Temples.

First Site
Coordinates: lat. 21°26'56" N long. 157°50'05" W

Second Site
Coordinates: lat. 21°27'21" N long. 157°50'20" W

Station F. Located at the USGS gaging station in the upper reaches of Waihee Stream; however, beginning with the 10 September sampling, this station was moved farther upstream approximately 183 m (200 yd) as the construction of a bridge begun just upstream of the original site, caused extreme turbidity and, consequently, changed the water quality. However, no data were collected on the turbid conditions resulting from the construction.

Coordinates: lat. 21°26'59" N long. 157°51'40" W

Station G. Located just beyond the bridge where Waikane Stream intersects Kamehameha Highway.

Coordinates: lat. 21°29'41" N long. 157°51'12" W

Station H. Located approximately 1.6 km (1 mile) upstream of Station G in the uppermost cultivated area where ginger plants and a prawn pond are located and accessible only with permission from the Roberts family.

Coordinates: lat. 21°30'02" N long. 157°51'56" W

The vicinity of each sampling location in Kaneohe Bay was designated by a U.S. Army Corps of Engineers representative; the actual positions are shown in Figure 1. Also shown are the downstream stations for each drainage subarea. Sampling of the Waikane Stream mouth, Station 12, was done 100 m (109 yd) directly offshore since water depths in the stream mouth area were too shallow to allow approach.

Station 1. Located off the Kaneohe Stream mouth.

Coordinates: lat. 21°24'55" N long. 157°47'13" W

Station 2. Located at the City and County of Honolulu Kaneohe sewer outfall.

Coordinates: lat. 21°25'14" N long. 157°47'06" W

Station 3. Located near the south end of Coconut Island.

Coordinates: lat. 21°25'58" N long. 157°47'37" W

Station 4. Located in the south end of the bay in open water.

Coordinates: lat. 21°25'43" N long. 157°46'37" W

Station 5. Located at the Kaneohe Marine Corps Air Station (KMCAS) sewer outfall.

Coordinates: lat. 21°26'20" N long. 157°45'52" W

Station 6. Located at the north end of Coconut Island.

Coordinates: lat. 21°26'27" N long. 157°47'22" W

Station 7. Located at the mouth of the south end of Kaneohe Bay in open water (adjacent to USCG Buoy No. 3).

Coordinates: lat. 21°27'57" N long. 157°47'04" W

Station 8. Located in the channel off the mouth of Kahaluu Stream.

Coordinates: lat. 21°27'48" N long. 157°50'38" W

Station 9. Located close to the mouth of Kahaluu Stream.

Coordinates: lat. 21°28'05" N long. 157°50'33" W

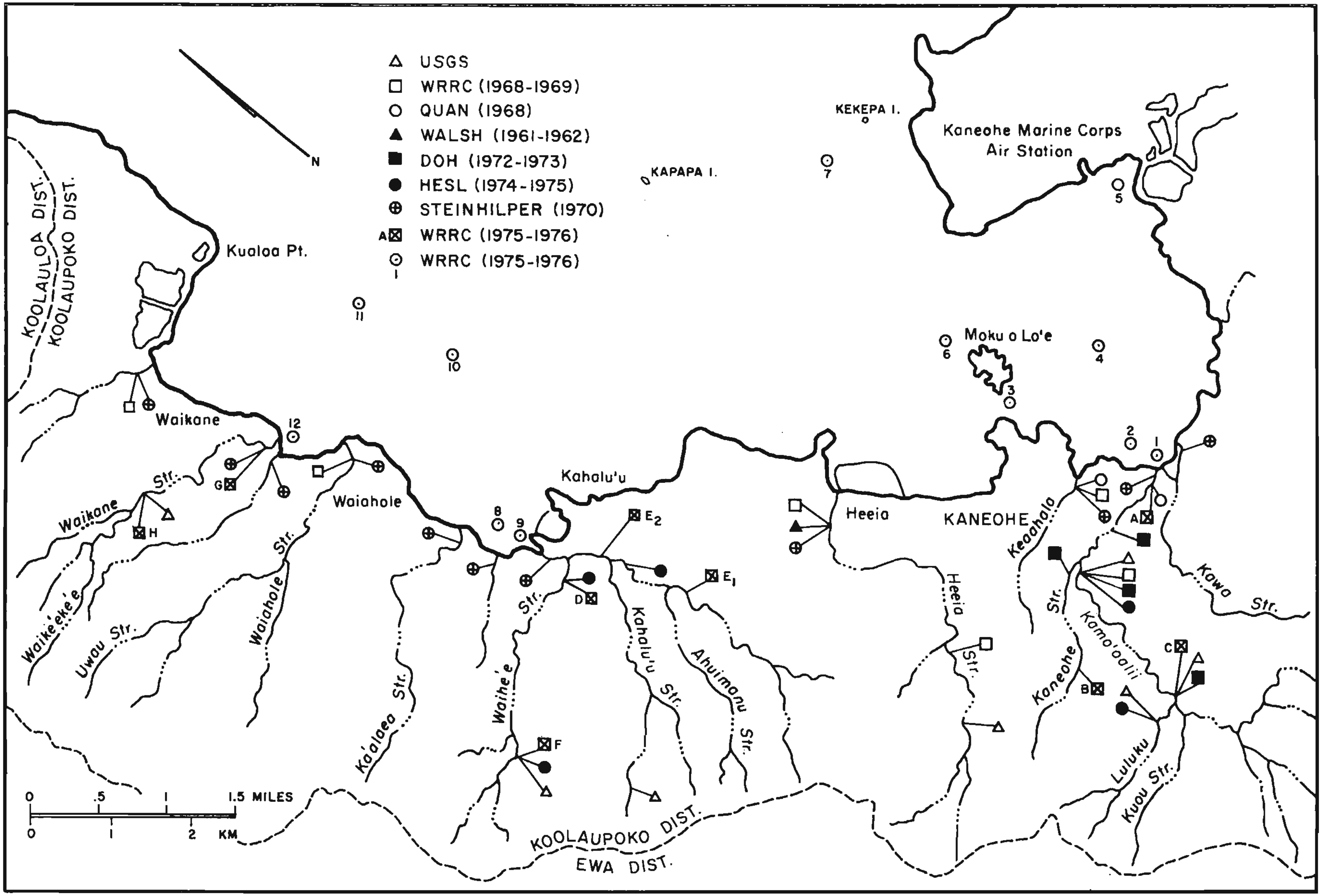

FIGURE 1. STREAM QUALITY SAMPLING LOCATIONS IN THE KANEOHE BAY DRAINAGE BASIN.

Station 10. Located at the north end of the bay (adjacent to USCG Buoy No. 13).
Coordinates: lat. 21°29'50.9" N long. 157°49'51.0" W

Station 11. Located at the north end of bay (adjacent to USCG Buoy No. 9).
Coordinates: lat. 21°29'45.6" N long. 157°49'59.7" W

Station 12. Located off the mouth of Waikane Stream.
Coordinates: lat. 21°29'34" N long. 157°51'05" W

FIELD METHODS

Sampling was categorized into two different areas, the freshwater streams and the Kaneohe Bay sites. For the first month of study (July 1975), samples were taken from both the stream and bay stations on a weekly basis. The bay station sampling was done on a monthly basis, samples being taken during the first week of the month (August to December). The stream sampling was continued on a weekly basis for an additional 2 months (August and September) and thereafter proceeded on a monthly basis to the end of the 6-mo study (October to December).

Sampling of the bay and stream stations was coordinated on the same day and at the same time with some success. However, the tidal fluctuations occasionally hindered the coordination since it was necessary to sample those nearshore bay stations during periods of high tide as they were inaccessible by boat during low water periods.

Automatic samplers (Sigma motor sequential samplers) were placed at three different stream stations, namely Stations A, D, and G. Twenty-four-hr composite samples were taken. Two samplers were placed at Stations D and G on the day prior to the scheduled sampling day and these samples were collected 24 hr later during the grab sampling. A sampler was then placed at Station A and that 24-hr composite sample collected the day after. This sampling schedule was necessary due to the availability of only two automatic samplers. The composite sample was kept in an iced container throughout the 24-hr sampling time.

Grab samples were taken in plastic bottles that were prepared for specific tests in mind. All bottles, with the exception of the heavy metals containers, were washed with chromic acid and rinsed with distilled-deionized water. The bottles were rinsed with the waters to be sampled before being filled. Forty milligrams per liter of mercuric chloride were added to one sample bottle and this bottle was stored in the ice chest for nutrient analysis. The other bottles were rinsed with the sample water, filled, and also stored in ice chests. The pesticide sample was taken in glass bottles that were washed with nanograde hexane prior to use. The heavy metal bottles were prepared by first soaking overnight in a 15% nitric acid solution and then rinsing with distilled, deionized water. To each bottle, 3 mℓ/ℓ of concentrated nitric acid were added. The bottles were not rinsed during collection due to the acid in the bottle.

Water samples for bacteria analysis were collected in autoclaved glass containers and were placed on ice for preservation and transport to the laboratory.

RESULTS AND DISCUSSION

The results presented in this section and subsequent discussion are directed toward the evaluation of the dry-weather quality data for the three drainage basins and the bay stations monitored. As noted in the Introduction, the data for the wet-weather runoff (last scheduled sampling survey) is not included. Separate discussions will be presented for the heavy metals and chlorinated hydrocarbon pesticide analyses.

Over 20 routine quality parameters were analyzed, most of these for each of the samples taken at the 20 monitoring stations. For ease of presentation, this array of data is summarized in four tables. Table 1 includes the pH, temperature, conductivity, chloride, turbidity, color, and dissolved oxygen data. Table 2 includes the 5-day biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), settleable solids, suspended solids (SS), and methylene-blue active substances (MBAS). Table 3 includes the nitrogen, phosphorus, and silica data. Table 4 includes the coliform and fecal streptococcus data. Each tabulation lists the median, mean, and standard deviations for the data available for each station and parameter. Streamflow data are also included in each of Tables 1 through 4. Sampling times, streamflow, and current directions of each sampling trip are presented in Appendix C. The raw data according to parameter, station, and sampling survey are provided in Appendix D.

TABLE 1. MEANS, STANDARD DEVIATIONS, AND MEDIANS OF pH, TEMPERATURE, CONDUCTIVITY, CHLORIDE, TURBIDITY, COLOR AND DISSOLVED OXYGEN

Station	Streamflow cfs mean	med.	pH mean	med.	Temp °C mean	med.	Conductivity μmho-cm mean	med.	Chloride mg/ℓ mean	med.	Turbidity NTU mean	med.	Color Units mean	med.	DO mg/ℓ mean	med.
A	6.68 ± 1.15	7.12	7.8 ± 0.4	7.8	24.8 ± 1.5	24.1	158 ± 60	157.5	19.2 ± 1.0	19.0	3.1 ± 2.3	2.7	13.0 ± 5.0	10.0	8.5 ± 0.6	8.4
A comp.			7.9 ± 0.2	7.8	--	--	141 ± 34	147.5	21.0 ± 6.4	19.5	2.9 ± 1.8	1.8	18.0 ± 10.0	15.0	--	--
B	0.71 ± 0.16	0.65	7.9 ± 0.3	7.8	22.8 ± 0.7	22.5	147 ± 30	94.0	17.1 ± 2.1	17.0	5.3 ± 0.8	5.5	25.0 ± 4.0	25.0	8.7 ± 0.4	8.7
C	4.00 ± 0.81	3.89	7.8 ± 0.2	7.9	23.5 ± 0.8	23.5	124 ± 35	123.5	17.1 ± 1.2	17.0	1.9 ± 0.8	1.8	10.0 ± 4.0	10.0	7.9 ± 2.2	8.4
D	3.37 ± 1.76	2.61	7.6 ± 0.2	7.5	25.0 ± 1.3	25.1	126 ± 29	130.0	16.3 ± 2.2	16.0	6.2 ± 3.2	5.2	28.0 ± 16.0	25.0	3.6 ± 1.2	3.2
D comp.			7.7 ± 0.2	7.6	--	--	123 ± 34	122.5	16.6 ± 1.3	16.5	5.7 ± 2.1	6.6	29.0 ± 13.0	25.0	--	--
E_1	0.81 ± 0.34	0.77	8.2 ± 0.4	8.1	26.9 ± 1.7	26.8	272 ± 0	272.0	35.0 ± 8.0	35.0	9.4 ± 5.1	8.3	56.0 ± 20.4	70.0	3.6 ± 0.9	3.7
E_2	3.06 ± 1.62	3.65	7.6 ± 0.2	7.5	24.3 ± 1.0	24.2	219 ± 50	220.0	29.4 ± 2.9	31.0	1.1 ± 0.6	0.7	21.4 ± 21.9	15.0	0.9 ± 0.9	0.6
F	1.67 ± 0.52	1.57	7.8 ± 0.3	7.8	21.0 ± 0.6	21.0	79 ± 33	77.5	12.4 ± 1.0	13.0	0.8 ± 0.7	0.5	5.0 ± 1.0	5.0	9.1 ± 1.1	8.9
G	0.78 ± 0.33	0.61	7.7 ± 0.2	7.7	23.6 ± 0.5	23.6	148 ± 28	142.0	19.8 ± 1.8	20.0	4.6 ± 0.8	4.7	25.0 ± 5.0	25.0	7.6 ± 0.8	7.5
G comp.			7.8 ± 0.2	7.8	--	--	156 ± 50	150.5	19.8 ± 2.0	19.5	4.5 ± 1.2	4.1	23.0 ± 5.0	22.5	--	--
H	0.60 ± 0.24	0.51	7.8 ± 0.2	7.9	22.3 ± 0.5	22.0	129 ± 34	83.0	16.9 ± 1.1	17.0	0.6 ± 0.3	0.6	6.0 ± 2.0	5.0	8.5 ± 1.0	8.4
1			8.3 ± 0.3	8.2	27.3 ± 1.1	28.0	34070 ± 8430 *29.19 ± 8.88	31000 32.15	16200 ± 5000	19020	4.0 ± 1.8	3.6	11.0 ± 4.0	10.0	6.8 ± 0.6	6.8
2			8.4 ± 0.3	8.5	27.0 ± 0.2	27.0	38000 ± 10000 *32.62 ± 2.84	40500 33.42	19300 ± 300	19370	3.1 ± 1.0	3.4	12.0 ± 3.0	10.0	6.5 ± 0.4	6.6
3			8.6 ± 0.3	8.7	27.1 ± 0.5	27.0	39800 ± 9440 *34.09 ± 0.35	43900 34.04	19500 ± 400	19400	1.9 ± 0.6	1.4	6.0 ± 2.0	5.0	6.7 ± 0.5	6.8
4			8.5 ± 0.4	8.6	26.6 ± 0.5	27.0	39500 ± 9100 *34.59 ± 0.31	44500 34.56	19800 ± 300	19900	1.2 ± 0.6	1.1	5.0 ± 0.0	5.0	6.4 ± 0.3	6.4
5			8.4 ± 0.3	8.4	26.2 ± 0.4	26.0	33130 ± 17820 *33.76 ± 0.94	42300 34.47	19100 ± 500	19050	2.9 ± 1.5	2.7	6.0 ± 2.0	5.0	6.3 ± 0.4	6.4
6			8.5 ± 0.4	8.5	26.6 ± 0.5	26.7	47000 ± 0 *34.67 ± 0.76	47000 34.47	19500 ± 500	19550	0.8 ± 0.4	0.6	5.0 ± 0.0	5.0	6.5 ± 0.4	6.5
7			8.5 ± 0.4	8.6	25.8 ± 0.7	25.8	45000 ± 0 *34.47 ± 0.56	45000 34.22	19700 ± 400	19800	.59 ± 0.3	0.5	5.0 ± 0.0	5.0	6.5 ± 0.4	6.5
8			8.5 ± 0.4	8.6	27.8 ± 1.2	27.8	46000 *34.04 ± 0.26	46000 33.87	19400 ± 400	19750	5.7 ± 3.8	5.4	16.0 ± 9.0	15.0	6.0 ± 0.3	6.0
9			8.4 ± 0.4	4.5	27.8 ± 1.6	29.0	33470 ± 13310 *28.20 ± 9.29	36500 29.92	16000 ± 5700	17400	4.3 ± 2.2	4.4	17.0 ± 6.0	15.0	6.0 ± 0.6	5.9
10			8.5 ± 0.4	8.6	26.8 ± 0.4	27.0	46800 *34.61 ± 0.43	46800 34.73	19700 ± 400	19750	0.5 ± 0.2	0.5	5.0 ± 0.0	5.0	6.1 ± 0.4	6.2
11			8.5 ± 0.4	8.6	26.8 ± 0.4	27.0	40700 *34.61 ± 0.46	40700 34.56	19800 ± 400	19900	1.4 ± 1.1	1.2	5.0 ± 0.0	5.0	6.1 ± 0.3	6.1
12			8.5 ± 0.3	8.4	27.5 ± 2.3	27.5	30870 ± 16800 *30.14 ± 1.35	38500 30.18	16500 ± 2400	8750	9.4 ± 5.8	7.8	30.0 ± 18.0	30.0	6.2 ± 0.4	6.2

*SALINITY ‰

TABLE 2. MEANS, STANDARD DEVIATIONS, AND MEDIANS OF BOD, COD, SETTLEABLE SOLIDS, SUSPENDED SOLIDS, AND MBAS

Station	Streamflow cfs mean	med.	BOD mean	med.	COD mean	med.	Sett. Solids mean	med.	Susp. Solids mean	med.	MBAS mean	med.
			mg/ℓ									
A	6.68 ± 1.15	7.12	< 2.0 ± 0.0	< 2.0	< 5.0 ± 0.0	< 5.0	0.1 ± 0.0	0.1	4.4 ± 2.4	3.8	0.014 ± 0.010	< 0.010
A comp.			< 2.0 ± 0.0	< 2.0	6.1 ± 2.7	< 5.0	0.1 ± 0.0	0.1	7.6 ± 6.7	6.0	0.016 ± 0.005	0.017
B	0.71 ± 0.16	0.65	< 2.0 ± 0.0	< 2.0	< 5.0 ± 0.0	< 5.0	0.1 ± 0.0	0.1	5.5 ± 1.7	5.0	0.011 ± 0.001	0.004
C	4.00 ± 0.81	3.89	< 2.0 ± 0.0	< 2.0	5.2 ± 0.6	< 5.0	0.1 ± 0.0	0.1	3.3 ± 1.2	3.0	0.012 ± 0.003	< 0.010
D	3.37 ± 1.76	2.61	2.6 ± 1.0	< 2.0	10.0 ± 10.0	6.9	0.3 ± 0.4	0.2	20.5 ± 28.3	12.4	0.012 ± 0.003	0.011
D comp.			3.0 ± 1.0	2.6	16.1 ± 16.7	9.8	0.2 ± 1.0	0.2	35.6 ± 49.0	17.1	0.011 ± 0.003	< 0.010
E_1	0.81 ± 0.34	0.77	5.4 ± 2.3	5.3	30.4 ± 5.4	31.4	0.3 ± 0.2	0.2	17.5 ± 8.5	14.9	0.058 ± 0.019	0.059
E_2	3.06 ± 1.62	3.65	< 2.0 ± 0.0	< 2.0	5.5 ± 0.8	< 5.0	0.1 ± 0.0	< 0.1	2.3 ± 1.7	1.8	0.021 ± 0.007	0.022
F	1.67 ± 0.52	1.57	< 2.0 ± 0.0	< 2.0	< 5.0 ± 0.0	< 5.0	0.1 ± 0.0	0.1	1.5 ± 1.1	1.4	0.010 ± 0.000	< 0.010
G	0.78 ± 0.33	0.61	< 2.0 ± 0.0	< 2.0	< 5.0 ± 0.0	< 5.0	0.1 ± 0.0	0.1	3.5 ± 2.3	2.8	0.012 ± 0.006	< 0.010
G comp.			< 2.0 ± 0.0	< 2.0	6.2 ± 2.2	< 5.0	0.1 ± 0.0	0.1	2.6 ± 1.1	2.4	0.033 ± 0.043	< 0.010
H	0.60 ± 0.24	0.51	< 2.0 ± 0.0	< 2.0	< 5.0 ± 0.0	< 5.0	0.1 ± 0.0	0.1	1.4 ± 1.3	1.8	0.011 ± 0.001	< 0.010
1			< 2.0 ± 0.0	< 2.0	--	--	< 0.1	0.1	13.3 ± 5.2	12.8	--	--
2			2.1 ± 0.2	< 2.0	--	--	< 0.1	0.1	12.3 ± 3.7	12.9	--	--
3			< 2.0 0.0	< 2.0	--	--	< 0.1	0.1	12.4 ± 9.2	12.9	--	--
4			--	--	--	--	< 0.1	0.1	11.1 ± 8.4	8.7	--	--
5			< 2.0 0.0	< 2.0	--	--	< 0.1	0.1	10.0 ± 3.5	9.7	--	--
6			--	--	--	--	--	--	8.4 ± 4.8	9.2	--	--
7			--	--	--	--	--	--	7.5 ± 5.4	8.4	--	--
8			--	--	--	--	0.1 ± 0.1	0.1	24.3 ± 13.1	19.6	--	--
9			< 2.0 ± 0.0	< 2.0	--	--	0.1 ± 0.1	0.1	16.1 ± 7.0	15.7	--	--
10			--	--	--	--	--	--	8.8 ± 4.5	6.6	--	--
11			--	--	--	--	--	--	10.4 ± 3.6	10.7	--	--
12			< 2.0 ± 0.0	< 2.0	--	--	0.3 ± 0.2	0.2	54.3 ± 41.0	33.0	--	--

TABLE 3. MEANS, STANDARD DEVIATIONS, AND MEDIANS OF NITROGEN AND PHOSPHORUS SPECIES AND SILICA

Station	Streamflow cfs		Ortho P		Total P		NH_4-N		TKN		NO_2-N		NO_2+NO_3-N		Total N		Silica	
			mg/ℓ															
	mean	med.	mean	med.	mean	med.	mean	med.	mean	med.	mean	med.	mean	med.	mean	med.	mean	med.
A	6.68 ±1.15	7.12	0.019 ±0.008	0.016	0.031 ±0.023	0.029	0.017 ±0.015	< 0.01	0.13 ±0.07	0.14	< 0.040	< 0.04	0.209 ±0.055	0.200	0.33 ±0.09	0.32	11.6 ±1.4	11.3
A comp.			0.011 ±0.010	0.008	0.058 ±0.068	0.035	0.030 ±0.033	< 0.01	0.19 ±0.07	0.20	< 0.040	< 0.04	0.155 ±0.074	0.139	0.32 ±0.11	0.37	11.0 ±0.7	11.2
B	0.71 ±0.16	0.65	0.016 ±0.012	0.012	0.032 ±0.034	0.018	0.018 ±0.020	< 0.01	0.12 ±0.06	0.13	< 0.040	< 0.04	0.059 ±0.024	0.055	0.17 ±0.06	0.19	13.5 ±1.6	13.0
C	4.00 ±0.81	3.89	0.17 ±0.008	0.017	0.035 ±0.028	0.024	0.028 ±0.036	< 0.01	0.12 ±0.09	0.13	< 0.040	< 0.04	0.353 ±0.108	0.380	0.51 ±0.08	0.50	11.7 ±1.4	11.3
D	3.37 ±1.76	2.61	0.161 ±0.057	0.169	0.293 ±0.095	0.262	0.505 ±0.303	0.485	1.21 ±0.66	0.94	0.12 ±0.04	0.12	0.469 ±0.105	0.448	1.68 ±0.66	1.34	14.0 ±1.6	13.5
D comp.			0.105 ±0.049	0.100	0.226 ±0.084	0.209	0.104 ±0.059	0.103	0.53 ±0.39	0.41	0.06 ±0.03	0.06	0.325 ±0.079	0.338	0.85 ±0.44	0.74	13.5 ±0.3	13.5
E_1	0.81 ±0.34	0.77	0.580 ±0.262	0.480	0.855 ±0.277	0.810	0.443 ±0.745	0.152	1.92 ±1.64	1.50	0.257 ±0.238	0.190	2.464 ±1.640	3.416	4.39 ±1.96	5.19	13.8 ±2.7	12.8
E_2	3.06 ±1.62	3.65	0.092 ±0.016	0.090	0.123 ±0.024	0.129	0.112 ±0.102	0.090	0.71 ±0.49	0.55	0.042 ±0.005	< 0.04	0.266 ±0.188	0.277	0.96 ±0.39	0.82	14.1 ±0.5	14.0
F	1.67 ±0.52	1.57	0.030 ±0.014	0.028	0.042 ±0.025	0.039	0.015 ±0.012	< 0.01	0.06 ±0.04	0.06	< 0.04	< 0.04	0.058 ±0.020	0.058	0.12 ±0.04	0.10	12.8 ±1.6	12.2
G	0.78 ±0.33	0.61	0.015 ±0.007	0.015	0.067 ±0.140	0.020	0.022 ±0.022	0.011	0.09 ±0.06	0.09	< 0.04	< 0.04	0.049 ±0.028	0.028	0.13 ±0.05	0.14	14.3 ±1.7	14.0
G comp.			0.011 ±0.006	0.011	0.023 ±0.011	0.022	0.025 ±0.026	< 0.01	0.12 ±0.07	0.12	< 0.04	< 0.04	0.055 ±0.022	0.033	0.16 ±0.11	0.16	14.0 ±0.4	13.9
H	0.60 ±0.24	0.51	0.011 ±0.006	0.011	0.025 ±0.022	0.016	0.019 ±0.021	< 0.01	0.08 ±0.06	0.11	< 0.04	< 0.04	0.068 ±0.020	0.059	0.15 ±0.06	0.14	14.4 ±1.6	13.9
1			0.021 ±0.008	0.02	0.061 ±0.031	0.055	0.041 ±0.025	0.028	0.11 ±0.06	0.15	< 0.04	< 0.04	0.078 ±0.071	0.035	0.18 ±0.09	0.18	2.2 ±0.9	0.53
2			0.139 ±0.058	0.111	0.214 ±0.091	0.199	0.335 ±0.147	0.300	0.39 ±0.24	0.46	< 0.04	< 0.04	0.062 ±0.033	0.043	0.54 ±0.57	0.49	0.5 ±0.2	0.45
3			0.028 ±0.014	0.033	0.050 ±0.028	0.044	0.020 ±0.018	0.014	0.06 ±0.03	0.07	< 0.04	< 0.04	0.048 ±0.016	0.034	0.11 ±0.03	0.10	0.1 ±0.05	0.10
4			0.023 ±0.008	0.02	0.039 ±0.029	0.030	0.028 ±0.018	0.020	0.07 ±0.06	0.08	< 0.04	< 0.04	0.042 ±0.005	0.025	0.10 ±0.06	0.08	0.2 ±0.1	0.18
5			0.195 ±0.180	0.175	0.264 ±0.206	0.255	0.168 ±0.204	0.083	0.47 ±0.40	0.34	< 0.04	≳0.04	0.078 ±0.053	0.060	0.55 ±0.36	0.39	0.75 ±0.5	0.6

TABLE 3. Continued.

Station	Streamflow cfs		Ortho P		Total P		NH_4-N		TKN		NO_2-N		NO_2+NO_3-N		Total N		Silica	
			-mg/ℓ-															
	mean	med.	mean	med.	mean	med.	mean	med.	mean	med.	mean	med.	mean	med.	mean	med.	mean	med.
6			0.025 ±0.019	0.025	0.041 ±0.031	0.025	0.029 ±0.020	0.026	0.03 ±0.02	0.04	< 0.04	< 0.04	0.040 ±0.002	0.021	0.05 ±0.03	0.04	0.1 ±0.04	0.1
7			0.014 ±0.005	0.013	0.037 ±0.027	0.021	0.032 ±0.028	0.025	0.03 ±0.02	0.64	< 0.04	< 0.04	0.041 ±0.002	0.031	0.06 ±0.02	0.05	0.1 ±0.04	0.1
8			0.012 ±0.006	0.011	0.046 ±0.030	0.043	0.027 ±0.020	0.021	0.07 ±0.02	0.06	< 0.04	< 0.04	0.043 ±0.058	0.026	0.09 ±0.02	0.10	0.5 ±0.2	0.55
9			0.027 ±0.025	0.02	0.061 ±0.049	0.038	0.042 ±0.032	0.028	0.12 ±0.09	0.14	< 0.04	< 0.04	0.061 ±0.050	0.026	0.17 ±0.11	0.16	3.5 ±5.1	1.55
10			0.010 ±0.007	0.009	0.019 ±0.028	0.010	0.022 ±0.016	0.017	0.05 ±0.05	0.06	< 0.04	< 0.04	0.051 ±0.028	0.022	0.09 ±0.07	0.04	0.2 ±0.05	0.2
11			0.009 ±0.005	0.008	0.022 ±0.027	0.013	0.031 ±0.026	0.024	0.10 ±0.17	0.05	< 0.04	< 0.04	0.046 ±0.012	0.029	0.13 ±0.16	0.04	0.2 ±0.08	0.17
12			0.021 ±0.020	0.02	0.071 ±0.045	0.056	0.031 ±0.024	0.024	0.09 ±0.05	0.12	< 0.04	< 0.04	0.061 ±0.028	0.020	0.15 ±0.07	0.15	1.2 ±4.3	1.05

TABLE 4. MEANS, STANDARD DEVIATIONS AND MEDIANS OF COLIFORMS

Station	Streamflow cfs		Total Coliform no./100 mℓ		Fecal Coliform no./100 mℓ		Fecal Streptococcus no./100 mℓ	
	mean	med.	mean	med.	mean	med.	mean	med.
A	6.68 ± 1.15	7.12	12,600 ± 9,300	11,800	1,340 ± 1,160	1,000	1,040 ± 1,300	570
A comp.			14,900 ± 21,000	7,000	3,000 ± 3,950	1,550	1,570 ± 2,560	600
B	0.71 ± 0.16	0.65	10,200 ± 18,500	5,200	4,220 ± 4,400	895	1,920 ± 2,640	915
C	4.00 ± 0.81	3.89	12,000 ± 16,000	7,300	425 ± 670	80	1,150 ± 2,110	465
D	3.37 ± 1.76	2.61	100,000 ± 84,000	78,000	19,900 ± 20,500	14,000	28,200 ± 45,500	3,200
D comp.			46,700 ± 24,600	50,000	15,600 ± 16,000	5,000	7,770 ± 9,440	50
E_1	0.81 ± 0.34	0.77	41,250 ± 51,420	25,000	630 ± 690	500	1,760 ± 2,790	450
E_2	3.06 ± 1.62	3.65	19,820 ± 17,620	20,000	3,900 ± 3,460	3,500	1,810 ± 3,260	460
F	1.67 ± 0.52	1.57	4,000 ± 2,700	4,300	330 ± 390	165	303 ± 190	285
G	0.78 ± 0.33	0.61	5,600 ± 3,800	6,800	780 ± 970	240	1,550 ± 1,610	550
G comp.			6,500 ± 9,150	4,500	1,350 ± 1,870	350	4,370 ± 13,400	600
H	0.60 ± 0.24	0.51	5,400 ± 4,150	4,000	830 ± 1,570	375	510 ± 790	200
1			1,200 ± 2,900	105	160 ± 340	20	240 ± 350	12
2			140 ± 190	35	10 ± 7	10	33 ± 41	17
3			3 ± 2	2	2 ± 0	2	2 ± 0	< 2
4			2 ± 0	2	2 ± 0	2	2 ± 0	< 2
5			135 ± 230	19	56 ± 110	2	24 ± 36	< 2
6								
7								
8			2 ± 0	2	2 ± 0	2	2 ± 0	< 2
9			1,120 ± 2,060	10	185 ± 370	10	91 ± 136	2
10								
11			2 ± 0	2	2 ± 0	2	2 ± 0	< 2
12			5 ± 3	4	9 ± 12.8	2	30 ± 41	4

Evaluation of Tables 1 through 4 does not reveal any new or significantly unexpected results. The quality of stream water in the northern subarea was better than in the central and southern subareas. The stream water quality in the central subarea was generally poorer than the southern subarea, probably due to the impact of the Ahuimanu Sewage Treatment Plant discharge into the Waihee Stream system and the fact that this was a larger drainage area. This is especially reflected in the higher nitrogen and phosphorus levels as well as bacteria concentrations for the downstream Waihee Stations D and E compared to the downstream Kaneohe Stations A and O. For all three subareas, the quality in the most upstream stations, B, F, and H, was about the same. But where there was little change from upstream to downstream in the relatively undeveloped northern sector, there were marked changes and deteriorations in quality in a downstream direction in Waihee and Kaneohe streams, and again the greatest difference can be noted in the nutrient and bacteria levels.

The bay waters of Stations 2 and 5 located at the outfall plumes are distinctive for generally poor quality as compared with the other bay stations. High concentrations of nutrients, bacteria, and lowered salinity were noted for Stations 1, 9, and 12 offshore of the stream mouths. It is interesting to note that the water quality for most parameters at Station 1, at the mouth of the major drainage channel for the most highly developed subarea, is in the same order of magnitude as for Stations 2 and 5.

There was little difficulty in the analysis of the reported water quality parameters and most of the data is considered reliable and reproducible. The standard deviations in Tables 1 to 4, where in some instances the deviation exceeds the mean value, are considered to be a result of the extreme range in value for some of the data, a consequence of grab sampling where small variations in suspended solids may be reflected in large variations in nutrient or bacterial levels associated with the solids. Also, where an arithmetic mean was used for the bacterial data, one or two extreme values can bias these results.

A brief discussion by parameter is presented for further evaluation purposes.

1. pH

   The mean pH values for all the stream stations were in a narrow range from 7.6 to 7.9. No extraordinarily extreme values were noted. Similarly, the range of mean pH for all bay stations was from 8.3 to 8.6. The respective values are within the state standards (State of Hawaii 1974, chap. 37-A, sec. B.2; App. F) for Class 2 (stream) and Class AA (bay) waters.

2. Temperature

The mean stream station temperatures were all lower than the mean bay station temperatures. Upstream temperatures were cooler (21.0 to 22.8°C or 70 to 73°F) than downstream temperatures (23.6 to 25.7°C or 74 to 78°F). Bay station temperatures were in a range from a mean of 25.8°C (78°F) at Station 7 to a mean of 27.8°C (82°F) at Stations 8 and 9. The most extreme variation, probably a result of the streamflow contributions, was noted at Stations 1, 9, and 12. The bay temperatures generally correspond with data obtained at the approximate sites of Stations 2, 4 through 8, and 11 in 1968 but the stream temperatures at Stations A, D, and G are cooler than that reported earlier by Young, Morphew, and Burbank in *Estuarine pollution* (Cox et al. 1973, pp. 267-301).

3. Conductivity - Chlorides

The range of mean chloride concentrations for the stream stations was from 12 mg/ℓ to 32 mg/ℓ, with most of the stations having levels of 16 to 20 mg/ℓ. The high mean value is from Station E, reflecting the Ahuimanu STP discharge. Most of the bay station mean values were between 19,400 to 19,800 mg/ℓ but lowered chloride levels were measured at the stream mouths as noted earlier. Only slightly lower chloride levels were measured over the sewer outfalls (19,100 and 19,300 mg/ℓ). Conductivity and salinity values generally corresponded with measured chloride concentrations.

4. Turbidity and Color

Turbidity and color concentrations were extremely low at most of the monitoring stations except for the most downstream stations, offshore at the stream mouths, and at the sewer outfalls. The mean value of stream turbidity was in a range from 0.6 to 6.3 units while the range for the bay waters was from 0.5 to 5.7 units. Similarly, the ranges for color were 5 to 36 units and 5 to 17 units.

5. Dissolved Oxygen (DO)

There was a broad range in DO in the streams from means of 2.2 and

3.6 mg/ℓ at Stations E and D to between 7.9 and 9.1 mg/ℓ for the other stations. The low levels at the two stations again reflect the impact of the Ahuimanu STP discharge and the large contributory watershed; these concentrations are less than the state standards for Class 2 waters. The mean DO concentration for all bay stations exceeded 6.0 mg/ℓ, the Class AA requirements.

6. BOD_5 and COD

The results for these two indirect measures of organic load indicate that organic contamination should not be considered a problem during dry-weather conditions. Most of the BOD_5 results are less than the detectable limits (< 2.0 mg/ℓ) according to *Standard methods*. Mean concentrations of 2.6 to 3.2 mg/ℓ were obtained for Stations D and E, and 2 mg/ℓ for Stations 2, 9, and 12. These data are only slightly less than that reported in the section on "Water quality" (pp. 267-301) by Young, Morphew, and Burbank for the 1968 field data in the WRRC study. COD was measured only on stream samples and, as with BOD_5, only mean values for Stations D and E were above the detection limits (5.0 mg/ℓ) for the method.

7. Solids

Both settleable solids and suspended solids data reflect the general high quality of the monitored waters. Mean values for most bay stations were less than 0.1 mg/ℓ for settleable solids, and for the stream stations the range was from 0.1 to 0.3 mg/ℓ. Suspended solids mean levels were from 1.5 mg/ℓ upstream to about 10 mg/ℓ downstream except at Station D where the mean was over 20 mg/ℓ. The mean suspended solids levels in the bay were in a range between 8 and 16 mg/ℓ except at Station 12. The mean at Station 12 was 54 mg/ℓ. This corresponds with the high turbidity and color noted for this station, and since the BOD_5 and settleable solids were low, it may be conjectured that a very fine suspended sediment load is the cause of the relatively high suspended solids value.

8. Methylene Blue Active Substance

Synthetic detergents, as measured by the test for methylene blue active substances (MBAS) as linear alkylate sulfonate (LAS), were only monitored in the stream waters. The range of mean values was from 0.01 to 0.04 mg/ℓ and, since there are no likely sources of sources of synthetic detergent contamination in upstream waters and the downstream values are of the same order of magnitude as the upstream values, it can be concluded that the 0.01 mg/ℓ is probably some background level and no serious MBAS contamination exists in the stream waters.

9. Phosphorus

Mean orthophosphate and total P concentrations for the streams were from 0.011 to 0.336 mg/ℓ and 0.025 to 0.461 mg/ℓ, respectively, from upstream to downstream stations. The lowest values were from the upstream Waikane station, while highest values were obtained at Stations D and E. Only those latter values exceed the state standards for Class 2 waters (0.20 mg/ℓ). Orthophosphate mean concentrations were in a range from 0.009 mg/ℓ at Station 11 to 0.195 mg/ℓ at Station 5. Total P mean concentrations were from 0.019 mg/ℓ at Station 10 to 0.264 mg/ℓ at Station 5. The quality level, in terms of total P, was within Class AA standards (0.020 mg/ℓ) for only Station 10, and just barely so. Levels at the sewer outfalls are one order of magnitude higher than at the other bay stations. No total P were available for comparison from the 1968 data of the WRRC study (Cox et al. 1973) but the orthophosphate concentrations are in the same order of magnitude for the stream and about one order of magnitude higher for the bay in this study.

10. Nitrogen

Total nitrogen mean values were in a range from 0.15 mg/ℓ at Station H to 2.54 mg/ℓ at Station E for the stream stations. The range in the bay waters was from 0.05 mg/ℓ at Station 6 to 0.55 mg/ℓ at Station 5. In general, the organic + ammonia fraction made up the majority of the N contribution except at the stations with highest total N levels, where the oxidized forms constituted the larger fraction (Stations A, C, D, and E). There are no state standards for Class 2 waters but the Class AA standard is 0.10 mg/ℓ which was equaled at Station 4 and exceeded at all other bay stations except 6, 7, and 8. No total N data are available for comparison from the 1968 data of the WRRC study (Cox et al. 1973).

11. Silica

The range of mean silica concentrations was from 11.7 to 14.4 mg/ℓ as Si for the streams and 0.1 to 3.5 mg/ℓ as Si for the bay stations. No pattern was discernable in the stream data and it can only be noted that the bay stations offshore from the stream mouths had the highest mean levels.

12. Coliform

Both total coliform and fecal coliform concentrations were obtained for stream and bay waters. The mean total coliform concentrations in the streams were from 4000/100 mℓ at Station F to 100,000/100 mℓ at Station D. Median levels were from 4000/100 mℓ at Station H to 78,000 at Station D. These median levels are all in excess of Class 2 standard requirements of 1000/100 mℓ. Mean total coliform concentrations in the bay were in a range from 2/100 mℓ at Stations 4, 8, and 11 to 1200/100 mℓ at Station 1. Only this latter station exceeded the Class AA requirement of 70/100 mℓ. The mean fecal coliform concentrations in the stream were from 330/100 mℓ at Station F to nearly 20,000/100 mℓ at Station D. These concentrations are all in excess of Class 2 requirements of a mean value of 200/100 mℓ. Mean fecal coliform levels in bay waters were in a range from 2/100 mℓ at Stations 3, 4, 8, and 11 to 160/100 mℓ at Station 1 and 185/100 mℓ at Station 9. The levels at the sewer outfalls were 10/100 mℓ at Station 2 and 50/100 mℓ at Station 5. There are no state fecal coliform standards for Class AA waters but one can presume that any indication of fecal contamination, i.e., identification of fecal coliform bacteria, would be indicative of an undesirable situation.

13. Fecal Streptococcus

The mean fecal streptococcal levels in the stream were from 300/100 mℓ at Station F to over 28,000/100 mℓ at Station D. The range in the bay stations was from 2/100 mℓ at several sites to 240/100 mℓ at Station 1. There are no standards for fecal streptococcus (FS), however, the fecal streptococcal concentration can be combined in a ratio with the fecal coliform (FC) concentration to indicate the probable source of pollution (FC:FS >4 = human, FC:FS <0.6 = warm-blooded animal, 4> FC:FS >0.6 = mixed or "old" human). Analysis of the FC:FS using *mean* values for each station (and not analysis of FC:FS data for individual sampling periods) yields a range from 0.3 to 2.4 as shown in Table 5.

TABLE 5. GEOMETRIC MEANS OF FECAL COLIFORM AND FECAL STREPTOCOCCUS, AND RATIO OF THE TWO

Station	Fecal Coliform	Fecal Streptococcus	FC:FS
	--------no./100 mℓ--------		
A	961	708	1.36
A comp	1,157	686	1.69
B	649	939	0.69
C	149	434	0.34
D	11,313	6,387	1.77
D comp	7,743	3,218	2.41
E	909	519	1.75
F	100	219	0.46
G	345	848	0.41
G comp	364	538	0.68
H	205	257	0.80
1	30	39	0.77
2	7	13	0.54
3	2	2	1.00
4	2	2	1.00
5	8	6	1.33
8	2	2	1.00
9	28	14	2.00
11	2	2	1.00
12	5	9	0.56

All the bacteria data for the streams corresponds, in order of magnitude, with the WRRC 1968 data (Cox et al. 1973).

Some of the samples were shared with the Department of Health (DOH) for analysis as a control procedure. These samples were from Stations A, D, and G on the streams, and 2, 9, and 12 on the bay. After the first two collection dates, Station 1 instead of 2 was utilized for this purpose. These data are listed in Appendix E. There was a generally close correspondence in all the water quality data discussed above as shown in Table 6. Differences may be noted in silica, reported as Si in this work and SiO_2 by the DOH, and in the bacteria data where a membrane filter procedure was used by WRRC and an MPN procedure by DOH.

The parameter concentrations for the streams in this dry-weather period

TABLE 6. STATISTICAL COMPARISON OF SPLIT SAMPLE RESULTS FURNISHED BY DEPARTMENT OF HEALTH AND WATER RESOURCES RESEARCH CENTER

Station	BOD_5 (mg/ℓ)		Sett. Solids (mg/ℓ)		Susp. Solids (mg/ℓ)		NO_2+NO_3-N (mg/ℓ)		TKN (mg/ℓ)	
	DOH*	WRRC†	DOH	WRRC	DOH	WRRC	DOH	WRRC	DOH	WRRC
A	< 2.0 ± 0.0	< 2.0 ± 0.0	< 1.0 ± 0.0	0.1 ± 0.0	4.2 ± 2.8	4.4 ± 2.4	0.24 ± 0.13	0.209 ± 0.055	0.15 ± 0.09	0.13 ± 0.07
A comp.	< 2.0 ± 0.0	< 2.0 ± 0.0	--	0.1 ± 0.0	3.2 ± 0.8	7.6 ± 6.7	0.15 ± 0.10	0.155 ± 0.074	0.18 ± 0.03	0.19 ± 0.07
D	3.3 ± 1.1	2.6 ± 1.0	< 1.1 ± 0.1	0.3 ± 0.4	11.7 ± 6.7	20.5 ± 28.3	0.45 ± 0.11	0.469 ± 0.105	1.25 ± 0.91	1.21 ± 0.66
D comp.	< 2.0 ± 0.0	3.0 ± 1.0	--	0.2 ± 0.1	59.0 ± 32.5	35.6 ± 49.0	0.44 ± 0.07	0.325 ± 0.079	0.97 ± 0.40	0.53 ± 0.39
G	< 2.0 ± 0.0	< 2.0 ± 0.0	< 1.0 ± 0.0	0.1 ± 0.0	3.3 ± 1.1	3.5 ± 2.3	0.15 ± 0.26	0.049 ± 0.028	0.11 ± 0.04	0.09 ± 0.06
G comp.	< 8.0 ± 10.4	< 2.0 ± 0.0	--	0.1 ± 0.0	2.0 ± 0.3	2.6 ± 1.1	0.17 ± 0.24	0.055 ± 0.022	0.14 ± 0.04	0.12 ± 0.07
1	--	< 2.0 ± 0.0	< 1.0 ± 0.0	< 1.0	12.2 ± 5.2	13.3 ± 5.2	0.02 ± 0.01	0.078 ± 0.071	0.24 ± 0.10	0.11 ± 0.06
9	--	< 2.0 ± 0.0	< 1.0 ± 0.0	0.1 ± 0.1	15.0 ± 4.0	16.1 ± 7.0	0.06 ± 0.04	0.061 ± 0.050	0.27 ± 0.03	0.12 ± 0.09
12	--	< 2.0 ± 0.0	< 1.0 ± 0.0	0.3 ± 0.2	57.2 ± 61.7	54.3 ± 41.0	0.02 ± 0.01	0.061 ± 0.028	0.32 ± 0.11	0.09 ± 0.05

Station	Total N (mg/ℓ)		Total P (mg/ℓ)		Total Coliform (no./100 mℓ)		Fecal Coliform (no./100 mℓ)		Fecal Streptococcus (no./100 mℓ)	
	DOH	WRRC	DOH	WRRC	DOH	WRRC	DOH	WRRC	DOH	WRRC
A	0.39 ± 0.11	0.33 ± 0.09	0.024 ± 0.010	0.031 ± 0.023	9953 ± 10076	12600 ± 9300	850 ± 609	1340 ± 1160	1700 ± 656	1040 ± 1300
A comp.	0.32 ± 0.11	0.32 ± 0.11	0.032 ± 0.008	0.058 ± 0.068	16933 ± 15646	14900 ± 21000	2063 ± 1255	3000 ± 3950	1430 ± 1089	1570 ± 2560
D	1.71 ± 0.90	1.68 ± 0.66	0.367 ± 0.287	0.293 ± 0.095	50750 ± 30478	100000 ± 84000	30000 ± 6272	19900 ± 20500	83200 ± 135814	28200 ± 45500
D comp.	1.40 ± 0.40	0.85 ± 0.44	0.215 ± 0.117	0.226 ± 0.084	27333 ± 6658	46700 ± 24600	23500 ± 707	15600 ± 16000	--	7770 ± 9440
G	0.23 ± 0.28	0.13 ± 0.05	0.025 ± 0.010	0.067 ± 0.140	5520 ± 6076	5600 ± 3800	312 ± 343	780 ± 970	313 ± 176	1550 ± 1610
G comp.	0.29 ± 0.20	0.16 ± 0.11	0.034 ± 0.008	0.023 ± 0.011	7650 ± 7566	6500 ± 9150	230 ± 0	1350 ± 1870	1080 ± 877	4370 ± 13400
1	0.26 ± 0.10	0.18 ± 0.09	0.047 ± 0.007	0.061 ± 0.031	166 ± 232	1200 ± 2900	41 ± 55	160 ± 340	30 ± 25	240 ± 350
9	0.30 ± 0.05	0.17 ± 0.11	0.177 ± 0.326	0.061 ± 0.049	29 ± 18	1120 ± 2060	17 ± 22	185 ± 370	727 ± 1449	91 ± 136
12	0.33 ± 0.11	0.15 ± 0.07	0.075 ± 0.044	0.071 ± 0.045	334 ± 374	5 ± 3	23 ± 15	9 ± 12.8	19 ± 22	30 ± 41

*Department of Health
†Water Resources Research Center

study coincide with work reported for other Oahu streams and summarized by Aoyama and Young (1974). Comparison with work reported for a comparable period in 1974 by Dugan (1975) in a study by the Hawaii Environmental Simulation Laboratory is difficult because the particular interest of the HESL work was differentiation between particulate and dissolved N and P concentrations; however, it appears that the corresponding data are also in the same order of magnitude.

Stream loadings were determined for BOD_5, SS, total N, and total P, using mean concentrations and flow data (Table 7). The load for each param-

TABLE 7. STREAM LOADINGS

Station	BOD_5	Susp. Solids	Total Nitrogen	Total Phosphorus
A	<110.2	242.6	17.6	1.7
B	< 11.5	31.7	1.0	0.2
C	< 66.9	110.4	17.1	1.2
D	< 57.7	591.6	48.5	8.5
E_1	23.6	76.3	19.2	3.7
E_2	< 33.0	37.9	15.8	2.0
F	< 28.0	21.0	1.7	0.6
G	< 13.5	23.6	0.9	0.5
H	< 10.0	7.0	0.8	0.1

eter increases in a downstream direction for each drainage basin. Highest loadings are at Station A, an order of magnitude greater than at Station C upstream and at the northern subarea. The N and P loads for Kaneohe Stream are twice the load reported in the WRRC 1968 study. Comparison of Station D with Kahaluu Stream data and Station G with Waikane Stream data from that study shows a 1.5- to 2-times increase at Station D and essentially no change at Station G (actually a lower N load reported from this work). These loadings are an excellent reflection of the degree of development or urbanization of the three study subareas.

CHLORINATED HYDROCARBON PESTICIDES

Water samples of Kaneohe Bay and selected watersheds, obtained and

and analyzed for dry water quality monitoring, included 40 grab samples from three streams collected at different times, 23 composite samples from the same streams, and 29 grab samples from Kaneohe Bay. The raw data of pesticides present in these water samples are provided in Appendix F and the locations of the sampling stations are shown in Figure 1.

Only α-chlordane, γ-chlordane, dieldrin, and pentachlorophenol (PCP) were found in all water samples in the low ppt (parts per trillion or nanogram per liter) range. Stream samples generally have slightly higher levels of pesticide residues than bay samples (Table 8).

TABLE 8. AVERAGE AND RANGE OF ORGANOCHLORINE PESTICIDE RESIDUES IN WATERS, JULY TO OCTOBER 1975

	No. of Samples	α-Chlordane	γ-Chlordane	Dieldrin	PCP*
		Concentration (ppt)			
Streams	63	2.4 (ND-15.3)	2.1 (ND-9.1)	3.7 (ND-17.1)	117.4 [39] (<10-479.8)
Bays	29	3.1 (0.5-4.5)	1.6 (ND-5.3)	1.7 (<0.5-8.8)	71.2 [13] (ND-378.5)
TOTAL	92	2.2 (ND-9.1)	1.9 (ND-15.3)	3.2 (ND-17.9)	105.9 [52] (ND-479.8)

NOTE: ND = Not detectable; figures in parentheses = range.
*PCP not analyzed in early part of study; number of samples analyzed indicated in brackets.

The data in this study are comparable to those found previously in other coastal water bodies and streams in Oahu, Hawaii as noted in Table 9 (Bevenue et al. 1972*a*; Lau et al. 1973). However, no trace of DDT and its degradation products (DDE, DDD) was detected in the present study. Previous results indicated that the presence of DDT in coastal waters was ubiquitous and only at a few parts per trillion level. The total absence of DDT in the present results is unexpected but may reflect the effect of the legal ban on DDT use a few years ago and which is now taking effect. (The federal ban in 1972 was preceded by gradual curtailment since 1968 in Hawaii.)

There are no prior pesticide data taken in the study area for comparison. Furthermore, it has been well established that the pesticide contents in coastal waters are much too low to discern their effect on the marine biota in relation to the adjoining land use, whereas pesticide contents in coastal sediments are remarkable indicators (Lau et al. 1973). Recognizing these limitations, it is perhaps still interesting to refer to previous data

TABLE 9. LEVELS OF ORGANOCHLORINE PESTICIDES FOUND PREVIOUSLY IN WATERS OF DIFFERENT AREAS IN OAHU, HAWAII

	No. of Samples	DDT	DDE	DDD	Dieldrin	Lindane	Chlordane α	Chlordane γ	PCP
		Concentration in parts per trillion							
Oahu Bays[1]	6	9.0 (0.4-41.0)	0.3 (0.1-0.6)	3.6 (0.1-10.0)	1.0 (0.1-3.0)	0.9 (0.3-2.0)			
Kalihi Str.[1]	2	3.3 (2.8-3.7)	ND	0.8 (ND-1.6)	9.9 (7.1-12.7)	ND			655 (168-1143)
Maunalua Bay[2]	33	1.4 (0.5-2.0)	ND	ND	0.6 (ND-3.0)	0.3 (ND-2.0)	0.4 (ND-2.0)	0.2 (ND-2.0)	7.6 (ND-41.0)
Sandy Beach[2]		0.9 (ND-4.0)	ND	ND	ND	ND	ND	ND	8.1 (1.0-30.0)

NOTE: ND = not detectable.
[1]Bevenue et al. 1972.
[2]Lau et al. 1973.

in coastal waters taken elsewhere in Hawaii. The average level of chlordanes found in this study is still in the range of a few parts per trillion but is somewhat higher in other previous data. The level of dieldrin detected is about the same as in previous studies.

Heptachlor was detected but at levels too low to be measured. Lindane was not detected (limit of detection is 0.5 ppt). PCBs (Aroclor 1254 was used as PCB standard) were not detected in the present study nor in any previous Hawaii studies (Bevenue et al. 1972*a*, 1972*b*; Crump-Wiesner, Feltz, and Yates 1974). The limit of detection for PCB for the present study was 50 ppt.

The effect of urbanization on the pesticide level in stream samples is clearly discernible as shown in Table 10. Except for PCP, the pesticide residues are highest in streams from areas of greater urban development.

TABLE 10. AVERAGE CONCENTRATION OF PESTICIDES IN STREAM WATER AS RELATED TO DEGREE OF URBANIZATION

	No. of Samples	α-Chlordane	γ-Chlordane	Dieldrin	PCP*
		Concentration (ppt)			
Urban	15	4.9	3.7	9.0	58.1 [9]
Urban/Rural	15	2.2	1.8	2.5	94.4 [6]
Rural	10	1.8	1.0	1.1	31.3 [3]

*PCP not analyzed in early part of study; number of samples analyzed in brackets.

α- and γ-chlordane and dieldrin are common pesticides found in termite control pretreatment of slab foundation houses; therefore, the positive relation between higher concentrations of these pesticides to urbanization found in this study is to be expected. However, the occurrence of PCP does not follow the same pattern. The consistently higher concentrations of PCP may be due to the high water solubility of its salts and derivatives. Because of its use as a termicide in construction timber, PCP concentration should be higher in urbanized areas with a predominance of dwellings constructed of wood. Information about the type of dwellings in this area is not available.

The results from one-time sampling and composite sampling are presented in Table 11. For α- and γ-chlordane and dieldrin, only Station A seems to indicate noticeably different results, the composite being lower. However,

TABLE 11. AVERAGE CONCENTRATION OF PESTICIDES IN STREAM WATER BY DIFFERENT SAMPLING METHODS

Station	No. of Samples	α-Chlordane	γ-Chlordane	Dieldrin	PCP*
		Concentration (ppt)			
A	5	7.0	4.9	10.3	70.8 [3]
D	5	2.1	1.8	0.7	157.1 [2]
G	5	2.1	1.0	1.3	40.9 [2]
A Comp.	8	1.9	1.7	3.1	80.0 [7]
D Comp.	6	1.0	1.3	0.9	127.3 [5]
G Comp.	9	1.0	1.3	1.6	277.6 [8]

*PCP not analyzed in early part of study; number of samples analyzed indicated in brackets.

the results remained consistent in that Station A had higher levels of residues than Stations D or G with either method of sampling. The trend in the PCP data has already been discussed above.

In the bay waters, analysis of residues at stations near sewer outfalls revealed no significant differences from samples taken at other stations, as can be seen in Table 12. There are no data on pesticide concentrations in

TABLE 12. AVERAGE CONCENTRATION OF ORGANOCHLORINE PESTICIDE RESIDUES IN BAY WATERS

	No. of Samples	α-Chlordane	γ-Chlordane	Dieldrin	PCP*
		Concentration (ppt)			
Stations near sewer outfalls	10	2.2	1.9	1.6	67.6 [5]
Other stations	9	1.5	1.5	1.8	73.5 [8]

*PCP not analyzed in early part of study; number of samples analyzed indicated in brackets.

the sewage effluent being discharged into Kaneohe Bay. It is known, however, that the essentially domestic sewage effluent from Mililani Town, Oahu, a burgeoning residential development of wood-constructed homes with concrete slab foundations, contained but a few ppt of pesticides (Lau et al. 1975*a*, 1975*b*).

Data from the Department of Health (DOH) shows nondetectable concentrations of pesticides (lindane, dieldrin, DDT, α-chlordane, γ-chlordane, PCB, PCP) in waters from Stations A, 1, and 9. Only one round (19 August 1976) of samples was analyzed by the Department of Health. It should be noted that the data is reported in parts per billion (ppb) as opposed to parts per trillion (ppt) for WRRC's data.

The means, standard deviations and medians of the WRRC pesticide data are listed in Table 13.

TABLE 13. MEANS, STANDARD DEVIATIONS, AND MEDIANS OF WRRC PESTICIDE DATA

Station	α-Chlordane mean and standard deviation	α-Chlordane median	γ-Chlordane mean and standard deviation	γ-Chlordane median	Dieldrin mean and standard deviation	Dieldrin median	PCP mean and standard deviation	PCP median	PCB mean and standard deviation	PCB median
	ppt									
A	7.0 ± 4.7	5.0	4.5 ± 1.5	4.5	10.3 ± 1.8	10.6	70.8 ± 53.5	71.6	ND*	
A comp	1.9 ± 1.3	1.2	1.7 ± 1.4	1.2	3.1 ± 0.8	2.8	80.0 ± 90.9	41.6	ND	
B	5.1 ± 1.4	5.0	4.9 ± 2.5	4.2	13.9 ± 3.6	12.8	44.9 ± 36.8	41.2	ND	
C	2.6 ± 0.9	2.6	2.4 ± 0.8	2.0	2.8 ± 1.1	3.0	61.6 ± 12.3	55.3	ND	
D	2.1 ± 1.1	1.8	1.8 ± 1.2	1.4	1.1 ± 0.6	0.9	157.1 ± 86.5	157.1	ND	
D comp	1.1 ± 0.2	1.2	0.9 ± 0.2	0.9	0.9 ± 0.3	0.8	107.3 ± 65.0	171.1	ND	
E	3.0 ± 0.8	3.1	1.3 ± 1.0	2.2	6.0 ± 1.4	5.9	72.5 ± 32.7	72.5	ND	
F	2.0 ± 1.8	1.4	1.6 ± 0.7	1.3	0.9 ± 0.3	1.0	53.6 ± 26.9	53.6	ND	
G	2.1 ± 1.9	1.2	0.9 ± 0.6	0.9	1.4 ± 1.5	0.8	40.9 ± 18.0	40.9	ND	
G comp	1.0 ± 0.4	0.9	2.1 ± 2.7	0.8	1.6 ± 1.3	1.0	277.6 ± 113.0	272.9	ND	
H	2.1 ± 1.7	1.6	1.2 ± 0.4	1.3	0.9 ± 0.2	0.9	21.7 ± 14.4	21.7	ND	
1	2.0 ± 1.4	1.7	1.8 ± 1.6	1.0	3.3 ± 3.3	1.6	157.8 ± 191.4	58.1	ND	
2	2.0 ± 1.3	1.5	2.2 ± 1.2	1.6	1.5 ± 0.7	1.2	54.2 ± 44.5	54.2	ND	
3	2.4 ± 1.7	1.5	1.7 ± 1.1	1.5	1.1 ± 0.4	1.0	<10.0 ± 0.0	<10.0	ND	
5	2.4 ± 1.5	1.9	1.7 ± 0.4	1.9	1.0 ± 0.8	1.6	76.5 ± 4.1	77.7	ND	
9	0.9 ± 0.3	1.0	1.3 ± 0.5	1.1	1.8 ± 1.2	1.6	15.9 ± 0.1	15.9	ND	
12	1.1 ± 0.5	1.2	1.4 ± 0.4	1.5	1.2 ± 0.5	1.1	82.5 ± 0.0	82.5	ND	

*Not detectable.

HEAVY METALS

Water samples obtained and analyzed for heavy metals included both bay and stream waters; the heavy metals analyzed by the WRRC included cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), and zinc (Zn). The detection limit was 5 ppb (parts per billion or microgram per liter) for Cd, Cr, Cu, Zn and was 3 ppb for Pb, Hg, and Ni. The WRRC raw data are tabulated in Appendix G.

The bay water sampled contained expectedly low concentrations of heavy metals, i.e., in the range of a few parts per billion. There is no discernible gradation of heavy metal concentration for the different parts of the bay. This range for Kaneohe Bay is comparable to that found in Oahu and Kauai coastal waters adjoining urban, agricultural, and undeveloped lands.

Stream water measured contain about the same level of heavy metals found in the bay water as noted in Table 14.

TABLE 14. CONCENTRATION OF HEAVY METALS IN KANEOHE BAY AND STREAM WATERS, JULY TO NOVEMBER 1975

	No. of Samples	Cd	Cr	Cu	Zn	Pb	Hg	Ni
		Concentration (ppb)						
Stream water	41	**	**-41	**-9	**	**	**	**
Bay water	23	**-9	**-45	**-20	**-13	**-4	**	**

** = 5 ppb for Cd, Cr, Cu, Zn, and 3 ppb for Pb, Hg, and Ni.

An aliquot of many water samples was sent to the State Department of Health (DOH) for heavy metal analysis (Cd, Cr, Cu, Pb, Hg, Zn) for interlaboratory calibration. The DOH raw data are reported in Appendix E. Comparison of the WRRC data and DOH data shows very good concordance. The few discrepancies are of insignificant magnitude to influence in any way the above conclusions. Furthermore, there are no consistent and significant differences in the results between grab and composite stream samples. The means, standard deviations, and medians for both the DOH data and WRRC data are listed in Table 15.

TABLE 15. MEANS, STANDARD DEVIATIONS, AND MEDIANS FOR THE DOH AND WRRC PESTICIDE DATA

WRRC Data

Station	Cadmium		Chromium		Copper		Lead		Mercury		Nickel		Zinc	
	mean and standard deviation	median	mean and standard deviation	median	mean and standard deviation	median	mean and standard deviation	median	mean and standard deviation	median	mean and standard deviation	median	mean and standard deviation	median
	ppm													
A	<0.005 ± 0.000	<0.005	0.023 ± 0.025	0.023	<0.005 ± 0.000	<0.005	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.005 ± 0.000	<0.005
A comp.	<0.005 ± 0.000	<0.005	0.006 ± 0.002	0.005	0.006 ± 0.002	0.005	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.005 ± 0.000	<0.005
B	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.005 ± 0.000	<0.005
C	<0.005 ± 0.000	<0.005	0.008 ± 0.004	0.008	<0.005 ± 0.000	<0.005	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.005 ± 0.000	<0.005
D	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.005 ± 0.000	<0.005
D comp.	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.005 ± 0.000	<0.005
E	<0.005 ± 0.000	<0.005	0.022 ± 0.024	0.022	<0.005 ± 0.000	<0.005	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.005 ± 0.000	<0.005
F	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.005 ± 0.000	<0.005
G	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.005 ± 0.000	<0.005
G comp.	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.005 ± 0.000	<0.005
H	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.005 ± 0.000	<0.005	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.003 ± 0.000	<0.003	<0.005 ± 0.000	<0.005
1	0.007 ± 0.002	0.006	0.032 ± 0.012	0.031	0.012 ± 0.003	0.011	0.003 ± 0.000	0.003	0.003 ± 0.000	0.003	0.003 ± 0.000	0.003	0.007 ± 0.003	0.006
2	0.008 ± 0.001	0.008	0.034 ± 0.008	0.034	<0.010 ± 0.000	<0.010	0.003 ± 0.000	0.003	0.003 ± 0.000	0.003	0.003 ± 0.000	0.003	<0.005 ± 0.000	<0.005
3	0.009 ± 0.000	0.009	0.030 ± 0.000	0.030	<0.010 ± 0.000	<0.010	0.003 ± 0.000	0.003	0.003 ± 0.000	0.003	0.003 ± 0.000	0.003	<0.005 ± 0.000	<0.005
5	0.007 ± 0.003	0.007	0.028 ± 0.004	0.028	<0.010 ± 0.000	<0.010	0.003 ± 0.000	0.003	0.003 ± 0.000	0.003	0.003 ± 0.000	0.003	0.006 ± 0.001	0.006
9	0.006 ± 0.001	0.005	0.031 ± 0.010	0.032	0.013 ± 0.004	0.011	0.003 ± 0.001	0.003	0.003 ± 0.000	0.003	0.003 ± 0.000	0.003	0.007 ± 0.003	0.006
12	0.006 ± 0.002	0.005	0.028 ± 0.009	0.025	0.013 ± 0.004	0.010	<0.003 ± 0.000	<0.003	0.003 ± 0.000	0.003	0.003 ± 0.000	0.003	<0.005 ± 0.000	<0.005

DOH Data

Station	Cadmium		Chromium		Copper		Lead		Mercury		Nickel		Zinc	
	mean and standard deviation	median	mean and standard deviation	median	mean and standard deviation	median	mean and standard deviation	median	mean and standard deviation	median	mean and standard deviation	median	mean and standard deviation	median
	ppm													
A	<0.001 ± 0.000	<0.001	0.007 ± 0.008	0.004	0.002 ± 0.001	0.003	0.016 ± 0.036	<0.001	<0.0002 ± 0.0000	<0.0002	0.003 ± 0.002	0.003	<0.001 ± 0.000	<0.001
A comp.	<0.001 ± 0.000	<0.001	0.004 ± 0.002	0.005	0.004 ± 0.003	0.003	0.001 ± 0.001	0.001	0.0003 ± 0.0002	0.0002	0.013 ± 0.011	0.013	0.002 ± 0.002	0.001
D	0.002 ± 0.002	0.001	0.007 ± 0.006	0.003	0.003 ± 0.002	0.004	0.002 ± 0.002	0.001	0.0003 ± 0.0003	0.0002	0.007 ± 0.002	0.007	0.003 ± 0.005	<0.001
D comp.	<0.001 ± 0.000	<0.001	0.004 ± 0.004	0.004	0.007 ± 0.002	0.007	0.002 ± 0.001	0.002	0.0006 ± 0.0005	0.0006	0.005 ± 0.000	0.005	0.003 ± 0.003	0.003
G	0.002 ± 0.003	0.001	0.011 ± 0.009	0.011	0.013 ± 0.025	0.003	0.009 ± 0.020	0.001	<0.0002 ± 0.0000	<0.0002	0.005 ± 0.004	0.006	0.004 ± 0.007	<0.001
G comp.	<0.001 ± 0.000	<0.001	0.005 ± 0.005	0.003	0.002 ± 0.002	0.002	0.002 ± 0.001	0.001	0.0013 ± 0.0018	0.0004	0.003 ± 0.002	0.003	<0.001 ± 0.000	<0.001
1	<0.001 ± 0.000	<0.001	0.004 ± 0.003	0.006	0.004 ± 0.003	0.004	0.002 ± 0.002	<0.001	0.0003 ± 0.0002	0.0002	0.004 ± 0.004	0.004	0.002 ± 0.003	<0.001
9	0.002 ± 0.000	<0.001	0.011 ± 0.012	0.005	0.004 ± 0.001	0.004	0.003 ± 0.001	<0.002	0.0006 ± 0.0008	<0.0002	0.003 ± 0.003	0.003	0.003 ± 0.004	<0.001
12	0.001 ± 0.001	0.001	0.018 ± 0.018	0.004	0.004 ± 0.005	0.002	0.003 ± 0.001	<0.002	0.0010 ± 0.0017	<0.0002	0.003 ± 0.002	0.003	0.001 ± 0.000	0.001

ERRORS, OMISSIONS AND FAILURES

Errors and failures were encountered in two general areas, that of the sampling and at the laboratory. The sample collection can be further subdivided into two groups, the stream and the bay sampling. For the stream sampling, collection of the samples was usually done with no problems encountered. However, there were a few instances when the automatic samplers failed to operate properly and thus no composite samples and data of certain stream stations on certain dates were obtained. Of these few failures, only one incident was directly attributed to human tampering, the remaining due to mechanical failure of some sort.

Another stream sampling failure occurred when attempts were made to reach Station H in the upper Waikane Valley. After a day of futile searching for the USGS gaging station that is supposed to be there, a site was chosen that was close to the location of that station as shown on the map. Accessibility to this site was a small problem at times since the Roberts family, who was called a day prior to the sampling day, could not be contacted a few times and thus the road into the valley was not opened and consequently no sample from Station H was taken.

Errors and failures in the bay were limited to one category, that of sampling at exactly the same point at each sampling date. Boat drift occurred during filling of the bottles and some stations, especially those along the outer areas of the bay where no marker buoys were present, were difficult to pinpoint exactly on each sampling day. These errors were quite negligible since the water quality in this open area is quite consistent over a wide area.

Attempts were made to always sample in the sewage boil at Stations 2 and 5. However, during the days of rougher bay waters, it was not always possible to exactly locate the upwelling. Also, on some days, especially low tide conditions, it was not possible to get within a hundred meters from land to sample at Stations 1, 9, and 12. Thus, a point was made to always sample the bay waters during high tide.

Failures in the laboratory were confined to two areas, accuracy of the analysis and the date of analysis. Initially, when the sampling was first started, wide ranges of dilutions and concentrations were done to insure successful analysis. However, the extremely low values of some parameters were below the limits of the range of standards and thus some parameters had to be deleted from the first sample analysis while others still within the maximum holding time limit had to be reanalyzed. For example, the BOD_5 values had to be deleted from the first sample data due to the extremely low value encountered and no holding time restriction.

Another area of concern was the holding of samples during the analysis period. The staff always tried to analyze the parameters before exceeding the maximum holding time. However, this was not achieved during the first two weeks of August and thus the scheduled 13 August sampling was cancelled and the time gained used to complete all unfinished analysis.

Breakdown of the conductivity meter resulted in erroneous data for conductivity for the first five sampling sessions. Use of a new meter corrected this problem.

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APPENDIX CONTENTS

TABLES

APPENDIX A. LABORATORY METHODS

Two basic references were used for the analysis of the water samples with the exception of silica: these are *Standard methods for the examination of water and wastewater* (APHA, AWWA, WPCF 1971, 13th ed.) and the Environmental Protection Agency's (EPA), *Manual of methods for chemical analysis of water and wastes* (1974). Also used was the Strickland and Parsons (1972) *A practical handbook of seawater analysis*.

Part of the measurement and analysis of the samples was done in the field. These included dissolved oxygen, temperature, flow quantity, time of day, and current direction. All the other parameters were analyzed in the laboratory, those requiring immediate analysis taking precedence over the others. The methodology used for each parameter is listed below.

1. Dissolved Oxygen (DO)

   This parameter was measured in the field with oxygen meters made by the Yellow Springs Instrument Company (YSI). The YSI Model 57 meter was used to measure DO in the streams and a YSI Model 51A meter was used for the bay stations. No dissolved oxygen measurements were done on the composite sample due to the 24-hr holding time. The meters were calibrated in the laboratory using the Winkler Method for DO determination as outlined in *Standard methods* (APHA, AWWA, and WPCF 1971, 218B, pp. 477-81). The meter was readable to 0.1 mg/ℓ.

2. Temperature

   The Yellow Springs Instrument meters used to measure dissolved oxygen also had temperature measuring capability and, thus, were used for temperature measurements in the field. The temperature was readable to 0.1°C.

3. pH

   The Orion Ionanalyzer Model 401 meter was used for this parameter. The meter was calibrated to pH 7.00 using standard pH reference buffer solution. Sensitivity of this measurement was 0.1 pH units.

4. Settleable Solids

   The settleable solids method, as outlined in *Standard methods* (224F, p. 539), was used for this determination. A 1-ℓ Imhoff cone was used and the solids determined by volume. Minimum detectable concentration is 0.1 mℓ/ℓ.

5. Suspended Solids

The method as outlined in *Standard methods* (224C, pp. 537-38) for total suspended matter was followed. A Whatman GF/C filter was used and 500 mℓ of sample was filtered unless high suspended matter was encountered, in which case a smaller volume was used. Minimum detectable concentration is 0.1 mg/ℓ.

6. Turbidity

Turbidity was measured with a Hach Model 2100A Turbidimeter, calibration being done with standard cells of known turbidity. Minimum value detectable is 0.01 nephelometric turbidity unit (NTU).

7. Conductivity

Conductivity was measured with a Yellow Springs Instrument (YSI) Model 33, Salinity, Conductivity and Temperature Meter, readable to within 1 $\mu\Omega\text{-cm}^{-1}$ on the lower setting for the stream samples and to within 100 $\mu\Omega\text{-cm}^{-1}$ units on the higher setting for the bay stations.

8. Biological Oxygen Demand (BOD_5)

This parameter was measured by using the method as outlined in *Standard methods* (219, pp. 489-95). Due to the low values encountered, 300 mℓ of seeded sample was used per analysis. The minimum detectable limit for this parameter is 2 mg/ℓ.

9. Chemical Oxygen Demand (COD)

The low level COD method as outlined in *Standard methods* (220, pp. 495-99) was used. Twenty milliliters of sample were used in the analysis. The minimum detectable concentration is 5 mg/ℓ. This was only performed on stream samples.

10. Nitrate Nitrite Nitrogen and Nitrite Nitrogen

The automated method for the determination of nitrite and nitrate nitrite nitrogen as outlined in the EPA's, *Manual of methods for chemical analysis of water and wastes*, pp. 207-14, was used for these parameters. This method incorporated the use of a cadmium reduction column with the Technicon Autoanalyzer. For nitrite-only determination, the cadmium column was removed to prevent nitrates from being converted to nitrites. The minimum detectable concentration for both of these parameters is 0.04 mg/ℓ NO_2+NO_3-N or NO_2-N.

11. Ammonia Nitrogen

The automated colorimetric phenate method as outlined in the EPA's manual, pp. 168-71 was followed using the Technicon Autoanalyzer. The minimum detectable concentration with this method is 0.01 mg/ℓ NH_4^+-N.

12. Total Kjeldahl Nitrogen (TKN)

This parameter, consisting of ammonia nitrogen plus organic nitrogen was determined by following the procedure as outlined in *Standard methods* (135, pp. 244-48). Five hundred milliliters of sample were used due to the low level of TKN encountered. Nesslerization, as outlined in *Standard methods* (132B, pp. 226-31), was used to obtain a 0.01-mg/ℓ-N concentration detectability.

13. Total Nitrogen

Total nitrogen values were obtained by summing the total Kjeldahl nitrogen and the nitrate nitrite nitrogen.

14. Orthophosphate and Total Phosphorus

The automated ascorbic acid reduction method as outlined in EPA's manual (1973, pp. 256-63) was followed, using the Technicon Autoanalyzer. The total phosphorus determination included a digestion step in an autoclave at 1.41 kg/cm^2 (20 psi) and 121°C for 30 min. The persulfate digestion method, as outlined in *Standard methods* (223C-III, p. 526) was followed. The minimum detectable concentration is 0.001 mg/ℓ-P.

15. Chlorides

The mercuric nitrate method was used for this determination. Both the low level and high level methods as outlined in *Standard methods* (112B, pp. 97-99) were used for the stream and bay samples, respectively. The minimum detectable concentration for the low level is 0.1 mg/ℓ Cl^- and 100 mg/ℓ Cl^- for the high level.

16. Silicates

The *1973 annual book of ASTM standards* D859, pp. 406-07, was the reference for this analysis. The colorimetric method, D, for silica was followed. The precision obtained from this test is 0.1 mg/ℓ-silica.

17. Synthetic Detergents

The methylene blue method for MBAS determination as outlined in *Standard methods* (159A, pp. 339-42) was followed. The minimum detectable concentration for this parameter is 0.025 mg/ℓ MBAS. This test was performed only on stream samples.

18. Bacteria (Total and Fecal Coliforms and Fecal Streptococcus)

The Standard Membrane Filter Procedure was followed as outlined in the EPA handbook, Environmental Protection Agency *Standard methods used by Region IX, Microbiology Laboratory* (1973) prepared by Kathleen C. Shimmin. Fifty-millimeter diameter Millipore filters of 0.45-μ pore size were used in conjunction with agar media. Initially, 5 dilutions for each station were prepared to obtain the range of values and thereafter three dilutions for each sample were made.

19. Oil and Grease

The separatory funnel extraction method as outlined in the EPA manual, (1973) pp. 229-31) was used. The minimum detectable concentration obtainable with this method is 5 mg/ℓ of oil and grease.

20. Streamflow

Streamflow measurements were taken in the field with a measuring stick, stopwatch, and an immersed floater. The velocity of the floater was recorded, the width and depth measured and the flow quantity was then calculated by:

$$Q_{avg} = 1/2\, w d_{avg}\, v_{avg}$$

where Q_{avg} = avg flow in cfs

W = width in ft

d_{avg} = avg depth in ft

v_{avg} = avg midstream velocity in fps

The one-half factor in the equation accounted for the decrease in velocity from midstream to the stream banks.

21. Current Direction

Bay current directions at Stations 1, 2, 9, and 12 were measured with drift bottles. The bottles were submerged and allowed to drift and the initial and final positions recorded.

22. Color

Color was measured by comparing the sample with known standards prepared as outlined in *Standard methods* (118, pp. 160-62). The results were reported as apparent color since no centrifuging for turbidity was done due to the relative clarity of the samples.

23. Salinity

Salinity was measured by following the low-precision method as outlined in *A practical handbook of seawater analysis* by Strickland and

Parsons (1972, pp. 17-19). Accuracy of this method is within 0.05 to 0.1% of salinity.

Heavy Metals

In preparation for analysis of stream and bay waters for heavy metals, careful selection of the most precise and accurate methods and procedures was undertaken and both standard EPA and USGS procedures and the most recent analytical literature were studied (Brown 1970; EPA 1974; Ediger 1973; APHA, AWWA, and WPCF 1971; Pettis and Phillips 1974). The following procedures were adopted:

One-liter samples for each stream and bay station were required. Polyethylene (Nalgene) 1-ℓ bottles were soaked a minimum of 12 hr in 15% nitric acid, rinsed twice in distilled-deionized water, and filled with 3.5 mℓ of 15% HNO_3; the latter amount was determined to be the necessary volume to lower the sample pH of both bay and stream samples to approximately 2, the level generally agreed to oxidize and dissolve all biogenic matter (EPA 1974; Brown 1970). In this state holding times of up to 6 mo have been prescribed for all metals except mercury. The times for the latter have been set at 38 days for glass containers and 13 days for hard plastic containers (EPA 1974). After collection, the samples were immediately frozen at 0°C. Analysis of samples for Ni, Cu, Pb, Zn, and Cd was done on a Perkin-Elmer model 305A atomic absorption spectrophotometer using Perkin-Elmer/EPA standard conditions (for emitter wavelength, air and acetylene flow, and emitter gain) for the appropriate element (EPA 1974). In order to attain sufficient accuracy, the USGS/EPA chelation-extraction techniques (Brown 1970; EPA 1974) were used (Table A-1). Analysis of samples for mercury was done on a Perkin-Elmer Coleman Mercury Analyzer (a cold vapor spectrophotometer) belonging to the Department of Botany, University of Hawaii. The following procedure was used in conjunction with the analyzer:

1. Measure exact sample volume--50-mℓ acidified sample
2. Heat to just below boiling temperature and allow to cool
3. Place in analyzer cell and inject 10 g stannous chloride
4. Read meter

The EPA (1974) gives the sample holding time in hard plastic bottles

TABLE A-1. CHELATION-EXTRACTION METHOD

Reagents
1. Ammonium pyrolidine dithiocarbamate (APCD)--1%, Prepare fresh daily
2. Bromphenol blue indicator--0.1 g in 100 mℓ of 50% ethanol
3. Appropriate metal standard solutions
4. HCl--0.3 M
5. Methyl isobutyl ketone (MIBK)
6. NaOH--2.5 M
7. Acidified demineralized water--3.5 mℓ 15% HNO_3 in 1 ℓ demineralized water
Procedure
1. Pipette 100-mℓ sample into separatory funnel
2. Prepare blank and sufficient standards and adjust volume to 100 mℓ with acidified demineralized water
3. Add 2 drops of bromphenol blue
4. Adjust pH of sample by addition of 2.5-$\underline{M}$ NaOH until blue
5. Add 0.3-$\underline{M}$ HCl drop by drop until blue just disappears in standard and sample, then add 2 mℓ of 0.2-$\underline{M}$ HCl, pH should be 2.4
6. Add 2.5 mℓ of APCD and shake, pH should be approximately 2.8
7. Add 10 mℓ of MIBK and shake for 1 min
8. Allow layers to separate
9. Discard aqueous layer and collect ketone phase in 15-mℓ centrifuge tube, cap, and centrifuge for 30 sec
10. Aspirate ketone layer and record scale reading for standards and samples

for mercury analysis as 13 days. Studies by Prof. Siegel* of the Department of Botany indicate that acidification of the sample to pH 2 is sufficient for complete dissociation of mercuric ions, thus preventing gaseous depletion. Freezing the sample is a further precaution in preservation.

Due to time constraints, the more complicated chromium extraction using $KMnO_4$ oxidation (Brown 1970) to convert trivalent Cr to the hexavalent state was not performed.

*Dr. Sanford M. Siegel 1976: personal communication.

Lower detection limits were determined to be those readings 50% of the blank reading. All lower detection limits are listed in Table 7. These limits are a function of contamination in the standard solutions and blanks due primarily to metal levels in the laboratory water. Reagent metal levels were determined to be minimal.

PESTICIDES

Standard practice specifies one procedure for the analysis of PCP and a separate procedure for the analysis of organochlorine pesticides and PCBs. A procedure to analyze both PCP and other pesticides residues in the same extraction has been constructed. The procedure consists primarily of modifications of and additions to the method found in *Analysis of pesticide residues in human and environmental samples* (Thompson 1974). The procedure of alkalizing the water samples during the extraction was adapted from the "Annual report of community studies on pesticides, Hawaii" (Klemmer 1974).

Procedure

1. Add 10 mℓ 1*N* $NaHCO_3$ to 1 ℓ of water sample.
2. Extract the alkaline water sample 2 times with 100 mℓ 15% methylene chloride in hexane, and 1 time with 100 mℓ hexane.
3. Wash the combined organic extracts with 100 mℓ of 2% Na_2SO_4 solution containing 0.01*N* $NaHCO_3$.
4. Combine the aqueous layers (extracts) from steps 2 and 3; acidify to pH 2 with concentrated H_2SO_4. Extract twice with 100 mℓ hexane. Evaporate the combined hexane extracts to about 5 mℓ in a Kuderna-Danish evaporator, dry over Na_2SO_4 and then treat with diazomethane solution. Apply suitable aliquot to the Electron Capture detector gas chromatograph (Micro Tek Model 220). Use 6-ft U-shaped glass columns packed with 4% SE-30/6% OV-210 and with 1.5% OV-17/1.95% OV 210 on 80/100-mesh gas-chromatograph Q. Column temperature at 175°C.
5. Evaporate the combined organic extracts (see step 3) to about 2 mℓ.
6. Prepare Florisil column: heat Florisil (60/100-mesh, PR grade) at 130°C overnight. Place a small wad of preextracted glass wool at the bottom of a 25 x 300-mm chromatographic column. Fill the column with 4 in.

(after settling) of the Florisil followed by 1/2-in. of anhydrous Na_2SO_4 and prewet with 40 mℓ petroleum ether.

7. Transfer the extract (see step 5) from the evaporator tube on the Florisil column and rinse the tube with two 2-mℓ portions of petroleum ether.
8. Elute the column with 200 mℓ of 15% diethyl ether in petroleum ether. Control the elution rate at 5 mℓ/min. Collect the eluate in a 500-mℓ Kuderna-Danish assembly and evaporate to about 1 mℓ.
9. Make a preliminary injection of 5 to 10 mℓ into gas chromatograph. If PCB peaks are present, then a silicic acid column is needed to separate PCBs from organochlorine pesticides.
10. Prepare silicic acid column: heat silicic acid (Mallinckrodt, 100-mesh powder) in oven at 130°C for 24 hr, add 3% water and allow to equilibrate in a tightly stoppered flask for at least 15 hr. Pack a chromaflex column (sz. 22, Kontes No. K-420550, C-4) with a slurry mixture of 5 g acid-washed Celite 545 (John Manville) and 20 g silicic acid in 80 mℓ petroleum ether.
11. Carefully add aliquot of 15% Florisil extract to silicic acid column.
12. Elute the column with 250 mℓ of petroleum ether. Collect eluate in a 500-mℓ Kuderna-Danish assembly. Control the elution rate to about 3 mℓ/min by applying dry compressed air. This eluate contains the PCBs.
13. When the petroleum ether approaches the upper edge of the adsorpant, elute the column again, this time with 200 mℓ of CH_3CN-hexane-CH_2Cl_2 (1:19:80). Collect this eluate with a fresh 500 mℓ Kuderna-Danish assembly. This new eluate contains organochlorine pesticides.
14. Evaporate each eluate to about 5 mℓ and analyze by gas chromatograph (see step 4). Column temperature at 200°C. The above procedure gave good recovery of PCP from spiked water samples. Recovery of other pesticides residues also was not adversely affected by alkalizing the water samples prior to extraction (Table A-2).

TABLE A-2. RECOVERY OF PESTICIDES ADDED TO WATER SAMPLE

Compound	Added ng/ℓ	Recovery, % Sample 1	2	3	Average Recovery %
Heptachlor	20	73	65	81	73
Aldrin	10	78	74	84	79
Heptachlor epoxide	20	88	73	84	82
α chlordane	20	93	74	88	85
γ chlordane	20	89	82	89	87
p, p'-DDE	20	98	94	94	95
Dieldrin	20	91	83	94	89
Endrin	40	100	95	92	96
p, p'-DDT	40	96	100	104	100
PCP	100	78	101	86	88
Aroclor 1254	1040	82	86	79	82

APPENDIX B. SAMPLE STORAGE AND HOLDING TIME

Sample storage and holding was done by following recommended procedures outlined in the EPA's, *Manual of methods for chemical analysis of water and wastes* (1974, pp. vi-xii). Mercuric chloride was used as the bacteriological inhibitor due to the longer holding time obtainable by using this preservative. It was used to preserve samples for nutrient analysis, namely nitrites, nitrates, ammonia, total Kjeldahl nitrogen, or the phosphates and total phosphorus. Samples for heavy metal were preserved with nitric acid and placed in the freezer upon return to the laboratory. All samples were refrigerated at 4°C. Bacteriological tests and BOD_5 analysis were done immediately upon return from sampling, usually between 4 to 7 hr after the first sample was taken. The other parameters were analyzed for in the order of their maximum holding time. Those parameters with a minimum holding time were analyzed before those others that could be kept longer. When the holding time was appreciably exceeded, the data was not reported.

APPENDIX C. SAMPLING TIME, STREAMFLOW, CURRENT DIRECTION

TABLE C-1. STREAMFLOW

Station	7/09/75	7/16/75	7/23/75	7/30/75	8/06/75	8/20/75	8/27/75	9/03/75	9/10/75	9/17/75	9/24/75	10/01/75	11/05/75
A	6.75	7.50	8.20	7.01	4.60	--	7.23	4.38	6.28	6.31	7.27	7.21	7.42
A comp.	--	--	--	--	--	--	--	--	--	--	--	--	--
B	0.56	0.79	0.57	0.54	0.91	0.64	0.60	0.65	0.67	0.53	0.88	0.85	1.01
C	4.63	5.10	4.63	5.58	3.89	3.96	3.32	3.00	4.00	2.79	3.76	3.47	3.83
D	7.60	6.78	3.17	3.37	2.97	3.38	2.45	2.61	2.32	2.52	2.10	2.21	2.34
D comp.	--	--	--	--	--	--	--	--	--	--	--	--	--
E	1.20	0.77	1.20	0.56	0.76	0.36	3.48	1.29	0.78	4.62	4.36	3.81	--
F	2.19	1.73	2.18	0.92	1.11	1.58	1.29	1.57	2.44	1.16	1.51	2.53	1.44
G	1.49	0.60	1.13	1.03	0.96	1.11	0.61	0.66	0.55	0.60	0.37	0.60	0.47
G comp.	--	--	--	--	--	--	--	--	--	--	--	--	--
H	1.26	0.81	0.62	0.53	0.46*	0.50	0.43	0.57	--	0.51	0.44	0.49	--

NOTE: cfs x 1.7 = m^3/min.
*8/07/75

TABLE C-2. SAMPLE COLLECTION TIME

Station	7/09/75	7/16/75	7/23/75	7/30/75	8/06/75	8/20/75	8/27/75	9/03/75	9/10/75	9/17/75	9/24/75	10/01/75	11/05/75
A	0945	1030	1205	1050	1100	1420	1130	1310	1445	1145	1130	1220	1155
A comp.	--	1230	1300	1050	1100	1420	1130	1310	1515	1230	1230	1300	1155
B	1145	1000	1225	1700	1125	1205	1040	1645	1135	1130	1115	1125	1100
C	0905	0930	1110	1010	1025	1230	1100	1710	1055	1205	1150	1140	1115
D	1310	1155	1410	1200	1215	1535	1450	1215	1300	1035	1030	1040	1020
D comp.	--	1315	1330	1200	1230	1500	1500	1300	1300	1035	1030	1040	1020
E	1235	1125	1355	1430	1155	1500	1350	1615	1310	1105	1050	1105	1030
F	1355	1500	1550	1555	1335	1605	1630	1545	1230	1020	1010	1015	0955
G	1535	1240	1435	1225	1415	1125	1545	1130	1205	1000	0950	0950	0930
G comp.	--	1400	1330	1225	1415	1125	1545	1130	1205	1000	0950	0950	0930
H	1515	1430	1518	1515	1240	1050	1515	1115	--	0930	0930	0930	--
1	1215	1151	1245	0915	1315	--	--	1125	--	--	--	1210	1030
2	1230	1200	1252	0930	1310	--	--	1140	--	--	--	1245	1050
3	1200	1257	1230	1015	1220	--	--	1105	--	--	--	1430	1125
4	1245	1206	1300	0935	1300	--	--	1200	--	--	--	1320	1100
5	1300	1217	1350	0940	1250	--	--	1200	--	--	--	1335	1110
6	1310	1246	1400	1005	1225	--	--	--	--	--	--	1355	--
7	1325	1235	1410	1000	1235	--	--	--	--	--	--	1415	--
8	1500	0920	1510	0845	1415	--	--	--	--	--	--	1100	--
9	1515	1108	1515	0830	1420	--	--	1305	--	--	--	1130	1010
10	1455	0905	1500	0855	1340	--	--	--	--	--	--	1145	--
11	1400	1010	1430	0820	1345	--	--	--	--	--	--	1010	--
12	1430	1035	1445	0755	1400	--	--	1245	--	--	--	1025	0930

TABLE C-3. CURRENT DIRECTION, AND OIL AND GREASE (mg/ℓ), 1975

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	10/01	11/05
A									
A comp.									
B									
C									
D									
D comp.									
E									
F									
G									
G comp.									
H									
1	IN	IN	IN	IN	IN	--	IN	IN	OUT
2	--	--	--	<5	<5	--	<5	--	
3									
4									
5	--	--	--	15.0	<5	--	<5	--	
6									
7									
8									
9	IN	IN	IN	IN	IN	--	IN	IN	IN
10									
11									
12	IN	IN	IN	IN	IN	--	IN	IN	OUT

APPENDIX D. WATER QUALITY DATA, 1975

TABLE D-1. BOD_5 (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
A comp.	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
B	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
C	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
D	--	--	<2	2.0	4.3	2.1	3.5	<2	<2	<2	<2	<2	4.7
D comp.	--	--	2.9	3.9	4.1	--	<2	4.6	2.6	<2	--	2.5	2.2
E	--	--	5.1	2.7	8.4	5.4	<2	<2	<2	<2	<2	<2	<2
F	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
G	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
G comp.	--	--	--	3.0	3.9	4.0	<2	<2	<2	<2	<2	<2	<2
H	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	--
1	--	--	<2	<2	<2	--	--	<2	--	--	--	<2	<2
2	--	--	<2	<2	<2	--	--	<2	--	--	--	2.4	<2
3	--	--	<2	<2	<2	--	--	<2	--	--	--	<2	2.0
4	--	--	--	--	--	--	--	--	--	--	--	<2	<2
5	--	--	<2	<2	<2	--	--	<2	--	--	--	<2	<2
6	--	--	--	--	--	--	--	--	--	--	--	--	--
7	--	--	--	--	--	--	--	--	--	--	--	--	--
8	--	--	--	--	--	--	--	--	--	--	--	--	--
9	--		<2	<2	<2	--	--	<2	--	--	--	<2	<2
10	--	--	--	--	--	--	--	--	--	--	--	--	--
11	--	--	--	--	--	--	--	--	--	--	--	--	--
12	--	--	<2	<2	<2	--	--	<2	--	--	--	<2	<2

TABLE D-2. COD (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
A comp.	--	7.4	14.7	5.0	<5	<5	<5	<5	<5	<5	<5	<5	7.3
B	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
C	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	7.3
D	6.0	9.5	6.6	<5	10.5	<5	<5	8.9	10.4	7.4	6.9	6.9	42.5
D comp.	--	<5	9.0	50.2	10.5	--	<5	44.4	10.4	8.6	--	<5	12.5
E	36.1	25.4	35.1	29.1	33.6	23.1	<5	<5	<5	6.7	<5	6.4	5.1
F	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
G	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	12.0
G comp.	--	<5	<5	5.6	8.8	<5	<5	<5	<5	7.4	<5	<5	--
H	<5	<5	<5	<5	<5	<5	<5	<5	--	<5	<5	<5	<5

TABLE D-3. SETTLEABLE SOLIDS (mℓ/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
A comp.	--	<0.1	0.1	<0.1	<0.1	--	--	--	<0.1	0.1	<0.1	<0.1	--
B	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
C	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
D	0.3	0.2	0.2	<0.1	0.2	0.1	0.15	0.1	0.2	0.3	0.3	0.1	1.6
D comp.	--	0.1	--	0.2	0.2	--	0.3	--	0.5	<0.1	--	--	0.3
E	0.2	0.6	0.3	0.15	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
F	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
G	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
G comp.	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	<0.1	<0.1	<0.1	<0.1	<0.1
H	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	<0.1	<0.1	<0.1	--
1	<0.1	<0.1	<0.1	<0.1	<0.1	--	--	<0.1	--	--	--	<0.1	<0.1
2	<0.1	<0.1	<0.1	<0.1	<0.1	--	--	<0.1	--	--	--	<0.1	<0.1
3	<0.1	<0.1	<0.1	<0.1	<0.1	--	--	<0.1	--	--	--	<0.1	<0.1
4	<0.1	<0.1	<0.1	<0.1	<0.1	--	--	<0.1	--	--	--	<0.1	<0.1
5	<0.1	<0.1	<0.1	<0.1	<0.1	--	--	<0.1	--	--	--	<0.1	<0.1
6	<0.1	<0.1	<0.1	<0.1	<0.1	--	--	--	--	--	--	<0.1	--
7	<0.1	<0.1	<0.1	<0.1	<0.1	--	--	--	--	--	--	<0.1	--
8	<0.1	0.1	<0.1	0.3	0.1	--	--	--	--	--	--	<0.1	--
9	<0.1	<0.1	<0.1	0.2	<0.1	--	--	0.2	--	--	--	<0.1	<0.1
10	<0.1	<0.1	<0.1	<0.1	<0.1	--	--	--	--	--	--	<0.1	--
11	<0.1	<0.1	<0.1	<0.1	<0.1	--	--	--	--	--	--	<0.1	--
12	0.4	0.6	<0.1	0.3	0.1	--	--	0.3	--	--	--	<0.1	<0.1

TABLE D-4. SUSPENDED SOLIDS (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	6.4	3.6	7.0	5.0	4.4	10.4	3.8	4.4	2.8	1.0	3.4	2.4	2.6
A comp.	--	10.0	23.4	--	6.0	--	--	6.0	5.4	2.6	11.0	3.4	1.0
B	10.2	4.8	6.8	5.0	6.0	6.8	4.8	5.0	6.0	4.4	3.6	3.6	5.0
C	3.0	2.2	5.0	5.4	4.4	4.6	2.0	3.4	3.0	2.4	3.6	1.4	2.8
D	13.6	8.6	11.8	10.6	11.8	11.8	11.0	14.6	16.0	14.6	15.6	12.4	114.5
D comp.	--	3.4	--	15.7	11.8	--	17.6	153.2	44.8	16.6	--	--	21.2
E	12.4	31.6	16.4	13.4	23.0	8.0	2.6	0.8	3.2	1.6	1.8	5.6	0.8
F	>0.1	1.0	3.2	2.2	1.0	2.8	0.4	2.6	1.4	0.2	3.0	1.4	0.4
G	2.2	5.0	3.8	4.0	3.0	2.2	1.8	2.0	3.0	2.8	10.6	2.4	2.6
G comp.	--	2.2	4.2	--	3.2	3.8	2.0	2.4	3.0	1.0	3.4	1.4	1.4
H	>0.1	0.8	4.2	1.8	1.8	2.4	0.4	0.2	--	<0.1	2.4	1.2	--
1	11.8	21.4	9.6	16.8	13.8	--	--	17.2	--	--	--	11.6	4.4
2	11.6	16.6	10.0	14.2	15.2	--	--	7.0	--	--	--	16.0	8.0
3	11.8	3.0	15.6	15.4	3.0	--	--	14.0	--	--	--	31.0	5.4
4	10.8	4.2	14.6	6.6	3.0	--	--	16.8	--	--	--	27.8	5.2
5	5.2	7.8	15.2	9.2	10.2	--	--	7.2	--	--	--	14.4	10.8
6	10.4	4.6	15.4	8.0	1.8	--	--	--	--	--	--	10.4	--
7	15.4	1.0	1.6	8.8	10.0	--	--	--	--	--	--	8.0	--
8	17.6	48.2	20.0	29.4	19.2	--	--	--	--	--	--	11.2	--
9	8.2	17.6	19.0	27.2	23.6	--	--	13.8	--	--	--	9.4	10.0
10	6.4	6.8	4.8	14.0	5.6	--	--	--	--	--	--	15.0	--
11	6.4	16.4	10.6	7.2	10.8	--	--	--	--	--	--	11.2	--
12	55.4	121.6	26.2	110.8	33.0	--	--	47.8	--	--	--	31.0	8.4

TABLE D-5. MBAS AS LAS (mg/ℓ)*

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	0.016	<0.01	0.016	0.045	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.011	<0.01	--
A comp.	--	0.016	0.025	0.019	<0.01	--	--	--	<0.01	0.018	--	0.014	--
B	0.011	<0.01	0.014	<0.01	0.012	<0.01	<0.01	<0.01	<0.01	--	<0.01	<0.01	--
C	<0.01	<0.01	0.015	<0.01	<0.01	<0.01	<0.01	0.021	<0.01	--	0.011	<0.01	--
D	0.015	<0.01	0.012	<0.01	0.010	<0.01	<0.01	<0.01	0.018	0.015	0.010	0.012	--
D comp.	--	<0.01	--	0.014	<0.01	--	<0.01	<0.01	0.016	<0.01	--	--	--
E	0.070	0.038	0.087	0.055	0.038	0.062	0.01	0.024	0.019	0.024	0.032	0.017	--
F	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	--	<0.01	<0.01	--
G	0.030	<0.01	<0.01	<0.01	<0.01	<0.01	0.013	<0.01	<0.01	--	<0.01	<0.01	--
G comp.	--	<0.01	0.121	0.081	<0.01	<0.01	<0.01	--	<0.01	--	--	<0.01	--
H	<0.01	<0.01	0.011	0.014	--	<0.01	<0.01	<0.01	--	<0.01	<0.01	<0.01	--

*Methylene blue active substance (MBAS) as Linear Alkylate Sulfonate (LAS).

TABLE D-6. pH

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	8.0	8.3	8.2	8.4	7.7	7.1	7.6	7.4	7.8	7.7	8.1	7.5	7.6
A comp.	--	8.3	8.2	7.7	8.0	7.8	7.8	7.7	7.6	8.0	7.9	7.6	7.7
B	8.0	8.4	8.2	8.0	7.5	7.5	8.0	7.6	7.8	7.6	8.1	7.7	7.8
C	7.9	8.2	8.1	8.0	7.6	7.7	7.9	7.6	7.7	8.0	8.1	7.6	7.6
D	7.7	7.6	7.7	7.9	7.4	7.5	7.5	7.5	7.3	8.0	7.6	7.4	7.3
D comp.	--	7.6	8.0	7.5	7.7	--	7.7	7.5	7.4	8.0	--	7.6	7.5
E	8.1	8.0	8.7	8.8	8.1	7.7	7.7	7.5	7.7	7.5	8.0	7.5	7.4
F	8.0	8.0	8.0	8.2	7.6	8.0	7.8	7.6	7.4	8.2	7.8	7.4	7.7
G	7.8	7.9	7.7	7.7	7.7	7.8	7.8	7.6	7.6	8.1	7.9	7.4	7.5
G comp.	--	8.1	7.8	7.4	7.7	7.8	7.8	7.7	7.5	8.0	7.9	7.6	8.2
H	7.9	8.0	7.9	7.8	7.5	7.8	7.9	7.7	--	8.1	8.0	7.6	--
1	8.0	8.0	8.6	8.0	8.8	--	--	8.4	--	--	--	8.0	8.4
2	8.1	8.7	8.8	8.0	8.8	--	--	8.6	--	--	--	8.1	8.3
3	8.2	8.9	8.8	8.1	8.9	--	--	8.6	--	--	--	8.7	8.6
4	8.1	8.8	8.8	8.0	8.8	--	--	8.6	--	--	--	8.1	8.6
5	8.1	8.8	8.7	8.0	8.8	--	--	8.4	--	--	--	8.2	8.4
6	8.1	8.8	8.8	8.0	8.8	--	--	--	--	--	--	8.2	--
7	8.2	8.9	8.8	8.0	8.8	--	--	--	--	--	--	8.3	--
8	8.2	8.9	8.8	8.1	8.8	--	--	--	--	--	--	8.3	--
9	8.0	8.9	8.8	8.0	8.9	--	--	8.5	--	--	--	8.0	8.4
10	8.2	8.9	8.8	8.1	8.8	--	--	--	--	--	--	8.3	--
11	8.2	8.8	8.8	8.0	8.8	--	--	--	--	--	--	8.3	--
12	8.2	8.9	8.8	8.0	8.8	--	--	8.4	--	--	--	8.2	8.3

TABLE D-7. TEMPERATURE (°C)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	24.0	23.0	24.5	24.1	24.3	27.0	25.8	25.6	28.0	23.7	23.8	23.7	23.6
A comp.	--	--	--	--	--	--	--	--	--	--	--	--	--
B	23.0	22.0	22.5	22.1	22.8	24.0	23.5	22.0	23.8	22.8	22.5	22.0	21.6
C	23.1	22.5	23.0	23.2	23.0	24.8	24.6	24.3	23.5	24.0	23.5	22.5	22.3
D	25.1	24.2	25.3	25.1	25.3	26.3	27.0	24.0	26.3	23.1	23.1	--	22.3
D comp.	--	--	--	--	--	--	--	--	--	--	--	--	--
E	25.0	25.5	28.0	29.4	25.8	27.8	25.2	24.3	26.0	23.4	23.9	24.2	23.2
F	21.0	21.2	21.0	21.4	21.9	21.8	21.5	20.5	21.5	20.3	20.0	20.3	20.0
G	24.0	24.0	23.8	24.0	23.5	23.6	23.3	23.8	24.5	22.8	22.8	23.0	22.6
G comp.	--	--	--	--	--	--	--	--	--	--	--	--	--
H	22.0	22.0	22.5	22.9	22.0	22.8	23.0	22.3	--	21.5	22.0	21.7	--
1	28.0	26.0	28.0	26.5	28.5	--	--	28.0	--	--	--	26.0	--
2	27.0	26.7	27.0	27.0	27.0	--	--	27.5	--	--	--	27.0	--
3	28.0	26.5	27.0	27.0	27.0	--	--	27.0	--	--	--	27.0	--
4	26.0	26.0	27.0	26.5	27.0	--	--	27.0	--	--	--	27.0	--
5	26.0	26.0	26.0	26.0	26.5	--	--	27.0	--	--	--	26.0	--
6	26.0	26.0	27.0	26.9	26.5	--	--	--	--	--	--	27.0	--
7	25.0	25.5	25.5	26.0	26.0	--	--	--	--	--	--	27.0	--
8	28.5	26.0	29.5	27.0	28.0	--	--	--	--	--	--	27.5	--
9	29.0	25.8	29.0	26.0	29.0	--	--	29.5	--	--	--	26.5	--
10	27.0	26.0	27.0	27.0	27.0	--	--	--	--	--	--	27.0	--
11	27.0	26.0	27.0	27.0	27.0	--	--	--	--	--	--	27.0	--
12	31.0	24.7	27.5	25.0	29.0	--	--	29.0	--	--	--	26.5	--

TABLE D-8. CONDUCTIVITY ($\mu\Omega\text{-cm}^{-1}$)

Station	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	242	172	140	130	152	210	145	43
A comp.	129	165	130	170	172	170	79	110
B	148	140	155	140	167	200	128	98
C	125	78	155	85	175	155	122	100
D	120	138	150	100	145	160	73	122
D comp.	--	140	130	110	172	--	69	115
E	272	250	220	180	242	290	136	218
F	47	95	85	70	140	100	36	59
G	124	158	145	110	201	170	139	136
G comp.	140	151	105	150	192	165	94	251
H	122	136	130	--	171	150	66	--
1	--	--	43600	--	--	--	31000	27600
2	--	--	46500	--	--	--	40500	27000
3	--	--	46500	--	--	--	43900	29000
4	--	--	45000	--	--	--	44500	29000
5	--	--	44500	--	--	--	42300	12600
6	--	--	--	--	--	--	47000	--
7	--	--	--	--	--	--	45000	--
8	--	--	--	--	--	--	46000	--
9	--	--	45000	--	--	--	36500	18900
10	--	--	--	--	--	--	46800	--
11	--	--	--	--	--	--	40700	--
12	--	--	42500	--	--	--	38500	11600

TABLE D-9. CHLORIDES (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	20.5	21.0	18.0	18.0	19.0	19.0	18.5	19.0	18.5	19.5	19.0	19.0	21.0
A comp.	--	18.5	19.0	19.5	20.5	18.0	19.0	19.0	17.5	20.0	19.5	19.5	40.2
B	23.0	14.5	16.0	16.5	15.5	17.5	16.0	17.0	15.5	17.5	17.0	18.0	19.0
C	18.0	18.5	16.5	16.5	15.0	16.0	17.0	18.0	16.0	17.5	17.0	17.0	19.5
D	18.0	21.5	15.0	15.0	15.5	14.0	15.5	17.0	15.0	16.0	16.5	17.5	18.5
D comp.	--	16.0	15.5	17.5	19.0	--	15.5	16.5	14.5	16.5	--	17.0	18.0
E	47.0	22.0	34.0	35.0	37.0	35.0	25.0	26.5	28.0	31.5	31.0	31.0	33.0
F	13.0	12.0	11.5	13.5	12.5	11.0	12.0	13.0	10.0	13.0	12.5	13.0	13.5
G	20.5	23.0	18.0	19.0	18.5	17.5	19.0	20.0	17.5	21.0	20.5	20.0	22.5
G comp.	--	24.5	18.5	19.0	18.5	18.0	19.5	19.5	17.0	20.5	19.5	20.0	22.5
H	17.5	16.0	15.5	16.0	16.5	15.5	17.5	17.5	--	19.0	17.0	17.5	--
1	6900	19800	10500	19600	19700	--	--	19500	--	--	--	14800	18500
2	19200	19000	18800	19600	19500	--	--	19300	--	--	--	19400	19500
3	19300	19300	18900	19000	19500	--	--	19700	--	--	--	20200	19800
4	15500	19500	19200	20000	19800	--	--	20000	--	--	--	20200	20000
5	18750	19500	18700	19800	19100	--	--	19500	--	--	--	19000	18400
6	19400	19700	19000	20100	19900	--	--	--	--	--	--	19000	--
7	19600	19700	19000	20000	19900	--	--	--	--	--	--	20100	--
8	18900	19500	19000	19700	19800	--	--	--	--	--	--	19600	--
9	3600	19400	16500	18300	18900	--	--	20000	--	--	--	15300	14500
10	20000	19800	19000	19500	19700	--	--	--	--	--	--	20100	--
11	19600	19900	19100	20100	19900	--	--	--	--	--	--	20100	--
12	14900	17000	17500	15900	17100	--	--	19100	--	--	--	18500	17400

TABLE D-10. TURBIDITY (NTU)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	5.0	2.8	4.6	1.3	3.6	9.2	3.0	2.7	2.6	1.5	1.0	1.4	0.9
A comp.	--	5.5	4.6	3.7	3.1	1.3	6.4	2.7	2.2	1.3	1.4	1.3	1.0
B	6.5	6.0	4.0	4.1	5.5	5.8	5.5	4.8	5.5	5.2	4.1	5.7	5.7
C	1.5	1.3	1.5	2.5	4.1	2.1	1.8	2.7	1.9	1.2	0.90	1.3	1.9
D	7.0	5.0	4.4	4.6	6.1	5.2	6.2	8.0	6.9	4.6	3.4	3.7	16.0
D comp.	--	3.8	3.7	7.3	6.8	--	7.7	20	8.7	4.8	--	5.7	6.4
E	10.0	19.0	5.5	7.3	9.3	5.2	0.74	1.7	0.65	0.67	0.70	2.2	1.2
F	1.5	0.60	0.40	0.45	0.77	0.40	0.47	3.0	0.43	0.32	0.50	1.1	0.57
G	5.5	5.5	3.2	4.4	4.9	3.9	5.1	5.8	3.9	4.4	3.5	4.7	5.3
G comp.	--	4.8	2.8	6.0	6.1	3.5	5.2	6.6	4.4	3.3	3.7	3.8	3.7
H	0.75	0.55	0.4	0.54	0.75	0.65	0.57	1.3	--	0.56	0.4	0.5	--
1	7.5	4.7	2.2	5.0	3.0	--	--	4.2	--	--	--	2.7	2.6
2	3.5	3.5	1.3	4.5	3.5	--	--	2.2	--	--	--	3.2	3.0
3	1.0	1.1	0.4	1.6	2.2	--	--	1.8	--	--	--	1.1	1.9
4	2.0	1.1	0.45	0.35	1.1	--	--	1.1	--	--	--	1.9	1.3
5	2.5	1.8	0.60	2.5	3.0	--	--	5.7	--	--	--	2.9	4.2
6	1.5	0.53	0.35	0.45	1.1	--	--	--	--	--	--	0.70	--
7	0.50	0.27	0.30	0.67	0.55	--	--	--	--	--	--	1.2	--
8	2.3	10.0	0.95	10	6.0	--	--	--	--	--	--	4.7	--
9	2.5	4.5	1.6	1.6	6.2	--	--	7.3	--	--	--	4.2	6.1
10	0.30	0.55	0.25	0.5	0.8	--	--	--	--	--	--	0.58	--
11	0.43	3.4	0.30	1.1	1.3	--	--	--	--	--	--	1.9	--
12	6.0	18.0	1.6	17.0	12.0	--	--	7.2	--	--	--	8.3	5.1

TABLE D-11. APPARENT COLOR

Station	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	10	15	10	10	25	15	20	10	10	10	10	10
A comp.	30	30	10	15	35	25	15	10	10	10	10	15
B	20	25	25	30	25	35	25	25	25	20	20	25
C	15	10	10	15	10	10	5	5	15	5	10	10
D	20	25	20	25	20	35	25	25	25	20	20	>75
D comp.	10	20	25	25	--	40	60	30	25	--	30	25
E	25	70	70	70	45	15	15	5	10	15	>70	20
F	5	5	5	5	5	5	5	5	10	5	5	5
G	35	25	25	30	15	30	25	25	20	20	20	2.5
G comp.	30	25	30	25	20	30	20	25	20	15	20	2.0
H	5	5	5	5	5	10	5	--	5	5	5	--
1	15	10	10	5	--	--	15	--	--	--	10	15
2	15	10	15	15	--	--	10	--	--	--	10	10
3	5	5	10	5	--	--	5	--	--	--	5	10
4	5	5	5	5	--	--	5	--	--	--	5	5
5	5	10	5	5	--	--	5	--	--	--	5	5
6	5	5	5	5	--	--	--	--	--	--	5	--
7	5	5	5	5	--	--	--	--	--	--	5	--
8	30	15	15	15	--	--	--	--	--	--	5	--
9	10	15	25	15	--	--	25	--	--	--	15	15
10	5	5	5	5	--	--	--	--	--	--	5	--
11	5	5	5	5	--	--	--	--	--	--	5	--
12	60	15	45	35	--	--	30	--	--	--	15	10

TABLE D-12. DISSOLVED OXYGEN (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	8.9	9.2	9.4	9.2	8.8	8.4	9.2	8.2	7.6	8.1	8.0	8.0	8.0
A comp.	--	--	--	--	--	--	--	--	--	--	--	--	--
B	9.0	9.1	8.8	8.4	8.7	8.8	9.1	8.3	7.8	8.6	8.7	8.8	8.6
C	8.3	9.2	9.3	8.9	8.7	8.5	8.8	7.5	8.4	8.3	8.3	8.0	8.2
D	6.8	3.0	3.1	3.5	2.7	4.3	4.7	3.2	2.6	4.4	3.0	2.8	3.3
D comp.	--	--	--	--	--	--	--	--	--	--	--	--	--
E	5.0	4.0	4.0	2.5	2.8	3.3	2.9	0.30	0.45	0.70	0.80	0.60	0.6
F	12.6	9.1	9.1	8.5	8.7	9.0	8.4	8.6	8.9	9.0	8.7	8.9	9.1
G	10.0	7.7	7.4	7.5	7.3	7.9	7.9	7.1	7.0	7.6	7.5	7.2	7.2
G comp.	--	--	--	--	--	--	--	--	--	--	--	--	--
H	11.4	8.6	8.2	8.4	8.0	8.6	8.6	8.0	--	8.1	7.8	7.5	--
1	7.4	7.2	6.8	5.7	6.4	--	--	6.6	--	--	--	7.2	--
2	7.0	6.7	6.6	5.8	6.2	--	--	6.6	--	--	--	6.5	--
3	7.1	7.4	6.4	6.8	6.8	--	--	6.2	--	--	--	6.2	--
4	6.5	6.7	6.4	5.8	6.4	--	--	6.4	--	--	--	6.7	--
5	6.4	6.9	6.4	5.6	6.4	--	--	6.3	--	--	--	6.2	--
6	7.1	6.8	6.4	5.9	6.3	--	--	--	--	--	--	6.5	--
7	7.0	6.9	6.4	5.8	6.6	--	--	--	--	--	--	6.2	--
8	5.7	6.3	6.1	5.6	5.9	--	--	--	--	--	--	6.2	--
9	5.4	6.8	6.4	5.0	6.3	--	--	5.9	--	--	--	5.9	--
10	5.7	6.1	6.3	5.6	6.5	--	--	--	--	--	--	6.2	--
11	6.1	6.3	6.1	5.4	6.3	--	--	--	--	--	--	6.1	--
12	6.0	6.8	6.2	5.6	6.6	--	--	6.4	--	--	--	6.2	--

TABLE D-13. SALINITY (‰)

Station	7/09	7/16	7/23	7/30	8/06	9/03	10/01	11/05
1	11.85	34.73	18.62	34.70	34.64	34.82	31.98	32.15
2	33.36	33.87	33.42	34.04	33.91	33.84	25.66	32.84
3	34.04	34.70	33.82	33.96	34.22	34.35	33.53	34.13
4	34.04	34.82	34.22	34.56	34.56	34.83	34.94	34.73
5	33.01	34.39	33.63	34.25	33.46	34.22	35.07	32.06
6	33.87	34.82	34.22	34.56	34.47	--	35.07	
7	34.04	35.35	33.87	34.22	34.44	--	34.90	
8	33.87	34.39	33.84	33.79	34.35	--	34.01	
9	6.42	34.39	29.92	32.06	33.15	34.99	26.42	28.23
10	34.13	35.13	34.04	34.73	34.73	--	34.90	
11	34.13	35.32	34.13	34.59	34.56	--	34.90	
12	29.04	30.18	31.29	27.91	30.82	31.84	--	29.92

TABLE D-14. ORTHOPHOSPHATE (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	11/05
A	0.035	0.018	0.015	0.020	0.016	0.023	0.011	0.013	0.013	0.014	0.008	0.019
A comp.	--	0.004	--	0.010	0.006	0.024	0.005	0.007	0.036	0.009	0.004	0.009
B	0.023	0.010	0.010	0.016	0.013	0.022	0.008	0.012	0.042	0.012	0.008	0.012
C	0.023	0.005	0.020	0.015	0.016	0.023	0.011	0.013	0.036	0.017	0.010	0.017
D	0.217	0.013	0.182	0.155	0.190	0.183	0.153	0.207	0.228	0.118	0.150	0.137
D comp.	--	0.013	--	0.155	0.103	--	0.096	0.106	0.180	0.090	--	0.094
E	0.717	0.235	0.422	0.403	0.875	0.828	0.091	0.083	0.101	0.080	0.078	0.119
F	0.064	0.005	0.025	0.025	0.028	0.038	0.027	0.026	0.042	0.030	0.022	0.026
G	0.029	0.008	0.012	0.018	0.020	0.020	0.019	0.010	0.008	0.021	0.007	0.009
G comp.	--	0.008	--	0.015	0.013	0.018	0.012	0.010	0.023	0.006	0.003	0.006
H	0.021	0.003	0.003	0.015	0.016	0.019	0.012	0.010	--	0.009	0.006	--
1	0.032	0.008	0.017	0.020	0.020			0.021				0.029
2	0.155	0.100	0.105	0.145	0.111			0.096				0.259
3	0.047	0.010	0.010	0.033	0.033			0.026				0.037
4	0.032	0.035	0.013	0.023	0.020			0.020				0.020
5	0.205	0.008	0.065	0.175	0.220			0.127				0.565
6	0.035	0.005	0.008	0.050	0.025			--				--
7	0.021	0.010	0.010	0.015	0.013			--				--
8	0.018	0.005	0.007	0.018	0.011			--				--
9	0.070	0.004	0.010	0.022	0.011			0.021				0.053
10	0.021	0.004	0.005	0.013	0.009			--				--
11	0.015	0.004	0.005	0.013	0.008			--				--
12	0.021	0.063	0.005	0.020	0.011			0.021				0.008

TABLE D-15. TOTAL PHOSPHORUS (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	0.100	0.018	0.036	0.023	0.021	0.050	0.031	0.029	0.029	0.011	0.014	0.016	0.030
A comp.	--	0.048	--	0.033	0.035	0.065	0.054	0.034	0.259	0.016	0.022	0.042	0.027
B	0.140	0.010	0.016	0.013	0.038	0.041	0.036	0.018	0.035	0.012	0.018	0.017	0.027
C	0.123	0.018	0.024	0.023	0.022	0.041	0.043	0.036	0.037	0.022	0.022	0.022	0.026
D	0.410	0.227	0.249	0.201	0.291	0.254	0.256	0.313	0.382	0.202	0.262	0.235	0.528
D comp.	--	0.088	--	0.193	0.178	--	0.209	0.367	0.323	0.182	--	0.269	0.221
E	1.316	0.607	0.677	0.615	0.967	0.948	0.133	0.129	0.128	0.079	0.106	0.146	0.143
F	0.120	0.023	0.026	0.036	0.038	0.051	0.044	0.043	0.039	0.027	0.039	0.025	0.040
G	0.102	0.013	0.012	0.033	0.013	0.042	0.032	0.028	0.526	0.014	0.016	0.016	0.020
G comp.	--	0.022	--	0.021	0.025	0.022	0.035	0.043	0.037	0.008	0.012	0.012	0.019
H	0.088	0.008	0.012	0.016	0.021	0.025	0.035	0.026	--	0.012	0.016	0.014	--
1	0.120	0.038	0.021	0.081	0.066			0.044				0.043	0.073
2	0.366	0.115	0.124	0.233	0.164			0.159				0.237	0.315
3	0.108	0.030	0.021	0.043	0.058			0.045				0.028	0.068
4	0.100	--	0.014	0.025	0.021			0.032				0.030	0.053
5	0.307	0.055	0.060	0.163	0.255			0.145				0.508	0.620
6	0.091	0.015	0.066	0.022	0.028			--				0.022	--
7	0.076	--	0.021	0.015	0.060			--				0.014	--
8	0.094	0.043	0.008	0.043	0.065			--				0.024	--
9	0.173	0.025	0.033	0.038	0.074			0.045				0.030	0.071
10	0.076	0.005	0.004	0.008	0.011			--				0.011	--
11	0.076	0.014	0.004	0.011	0.013			--				0.011	--
12	0.129	0.093	0.021	0.126	0.043			0.061				0.034	0.050

TABLE D-16. AMMONIA (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01
A	0.023	0.064	0.018	0.012	<0.01	<0.01	<0.01	<0.01	0.012	<0.01	<0.01	<0.01
A comp.	--	0.068	--	0.039	<0.01	0.014	<0.01	<0.01	--	<0.01	<0.01	<0.01
B	0.030	0.080	0.017	0.012	<0.01	<0.01	<0.01	<0.01	0.012	<0.01	<0.01	<0.01
C	0.038	0.136	0.024	0.044	<0.01	<0.01	0.024	<0.01	<0.01	<0.01	<0.01	<0.01
D	0.675	1.18	0.835	0.480	0.405	0.510	0.279	0.627	0.489	0.063	0.374	0.144
D comp.	--	0.149	--	0.095	0.106	0.144	0.039	0.103	0.083	0.011	--	0.209
E	0.216	0.156	0.053	0.148	0.125	1.96	0.124	0.017	0.060	0.043	0.300	0.127
F	--	0.051	0.015	0.020	<0.01	<0.01	0.012	<0.01	<0.01	<0.01	<0.01	<0.01
G	0.033	0.086	0.014	0.039	0.011	<0.01	0.020	<0.01	<0.01	0.010	0.011	<0.01
G comp.	--	0.071	--	0.071	0.012	--	<0.01	<0.01	<0.01	<0.01	0.025	<0.01
H	<0.01	0.076	0.010	0.041	0.012	<0.01	<0.01	<0.01	--	<0.01	0.011	<0.01
1	0.055	0.084	0.013	0.056	0.022			0.028				0.028
2	0.255	0.376	0.300	0.425	0.591			0.133				0.262
3	<0.01	0.060	0.016	0.010	0.020			0.010				0.014
4	0.020	0.063	0.012	0.031	0.040			0.016				0.014
5	0.079	0.083	0.041	0.156	0.152			0.047				0.618
6	0.026	0.067	0.014	0.026	0.029			--				0.012
7	0.019	0.084	0.01	0.031	0.034			--				0.011
8	0.019	0.066	0.013	0.032	0.022			--				0.012
9	0.100	0.066	0.014	0.052	0.028			0.016				0.020
10	<0.01	0.051	0.012	0.022	0.026			--				<0.01
11	0.013	0.077	0.011	0.040	0.035			--				0.010
12	0.019	0.048	0.010	0.077	0.026			0.024				0.011

TABLE D-17. TKN (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	0.07	0.14	<0.01	0.08	0.23	0.23	0.15	0.18	0.14	0.15	0.11	0.08	0.05
A comp.	--	--	0.14	0.28	0.12	0.30	0.19	0.21	0.07	0.21	0.24	0.14	0.11
B	0.06	0.09	<0.01	0.16	0.03	0.21	0.15	0.17	0.11	0.18	0.14	0.11	0.10
C	0.04	0.17	<0.01	0.14	0.10	0.15	0.17	0.12	0.12	0.33	0.15	0.07	0.06
D	0.95	1.76	0.58	0.66	1.74	0.66	0.73	2.48	2.10	0.58	1.40	0.93	1.58
D comp.	--	0.26	0.10	0.55	0.10	--	0.36	1.19	0.89	0.41	--	0.92	0.41
E	0.60	1.43	0.69	1.57	2.19	5.05	0.37	0.30	0.55	0.48	1.00	1.70	0.56
F	0.04	--	<0.01	0.03	0.03	0.09	0.08	0.12	0.09	0.13	0.04	0.03	<0.01
G	0.04	0.15	<0.01	0.03	0.08	0.15	0.12	0.12	0.05	0.18	0.09	0.08	0.05
G comp.	--	--	0.04	0.08	0.14	0.28	0.12	0.12	<0.01	0.21	0.13	0.06	0.03
H	0.01	--	<0.01	0.05	<0.01	0.14	0.11	0.06	--	0.14	0.19	0.10	--
1	0.13	--	<0.01	0.16	0.05			0.15				0.15	0.09
2	0.45	0.47	<0.01	0.27	0.48			0.24				0.78	1.17
3	0.06	0.06	<0.01	0.07	0.04			0.10				0.10	0.13
4	0.08	0.06	<0.01	<0.01	0.04			0.12				0.18	0.10
5	0.34	--	0.08	1.0	0.33			0.14				0.95	0.43
6	0.04	0.06	<0.01	<0.01	0.01			--				0.04	--
7	0.04	--	<0.01	<0.01	0.06			--				0.04	--
8	0.05	--	0.06	0.04	0.08			--				0.10	--
9	0.14	--	0.01	0.03	0.14			0.15				0.26	0.05
10	0.02	--	0.08	<0.01	0.12			--				0.04	--
11	0.40	--	0.08	<0.01	0.01			--				0.02	--
12	<0.01	0.12	0.12	0.08	0.09			0.16				0.05	--

TABLE D-18. NITRITES (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/20	8/27	9/03	9/10	9/17	9/24	10/01
A	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
A comp.	--	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
B	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
C	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
D	0.098	0.068	0.115	0.130	0.080	0.150	0.122	0.146	0.054	0.194	0.138
D comp.	--	0.042	<0.04	0.067	--	0.049	0.065	0.085	<0.04	--	0.113
E	<0.04	<0.04	0.190	0.463	0.550	0.053	<0.04	<0.04	<0.04	<0.04	<0.04
F	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
G	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
G comp.	--	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
H	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	--	<0.04	<0.04	<0.04
1	<0.04	<0.04	<0.04	<0.04			<0.04				<0.04
2	<0.04	<0.04	<0.04	<0.04			<0.04				<0.04
3	<0.04	<0.04	<0.04	<0.04			<0.04				<0.04
4	<0.04	<0.04	<0.04	<0.04			<0.04				<0.04
5	<0.04	<0.04	<0.04	<0.04			<0.04				<0.04
6	<0.04	<0.04	<0.04	<0.04							<0.04
7	<0.04	<0.04	<0.04	<0.04							<0.04
8	<0.04	<0.04	<0.04	<0.04							<0.04
9	<0.04	<0.04	<0.04	<0.04			<0.04				<0.04
10	<0.04	<0.04	<0.04	<0.04							<0.04
11	<0.04	<0.04	<0.04	<0.04							<0.04
12	<0.04	<0.04	<0.04	<0.04			<0.04				<0.04

TABLE D-19. NITRATE + NITRITES (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	0.250	0.310	0.270	0.228	0.230	0.275	0.185	0.172	0.165	0.140	0.144	0.152	0.200
A comp.	--	0.225	0.310	0.168	0.120	0.155	0.194	0.174	0.122	<0.04	0.114	0.084	0.120
B	<0.04	0.105	0.110	0.055	0.050	0.060	0.044	0.058	0.057	<0.04	0.036	0.074	0.040
C	0.393	0.430	0.495	0.376	0.385	0.338	0.393	0.429	0.340	0.350	0.335	0.293	<0.04
D	0.448	0.355	0.470	0.480	0.425	0.380	0.552	0.518	0.533	0.410	0.746	0.349	0.430
D comp.	--	0.245	0.200	0.350	0.255	--	0.371	0.440	0.425	0.325	--	0.354	<0.04
E	>0.5	1.520	4.700	3.416	3.500	1.150	0.308	0.277	0.200	0.340	0.087	<0.04	0.610
F	0.058	0.065	0.100	0.069	0.050	0.088	0.040	0.073	0.043	<0.04	0.049	0.044	<0.04
G	<0.04	<0.04	0.143	0.045	0.055	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
G comp.	--	0.055	0.080	0.065	<0.04	0.085	<0.04	<0.04	<0.04	0.100	<0.04	<0.04	<0.04
H	0.065	0.095	0.113	0.059	0.080	0.058	0.049	0.064	--	0.055	0.056	0.058	--
1	0.235	0.060	0.130	<0.04	0.040			<0.04				<0.04	<0.04
2	<0.04	0.050	0.108	<0.04	0.055			<0.04				<0.04	0.12
3	<0.04	0.085	0.053	<0.04	0.045			<0.04				<0.04	<0.04
4	<0.04	<0.04	0.053	<0.04	<0.04			0.043				<0.04	<0.04
5	0.040	<0.040	0.095	0.054	0.072			0.058				0.062	0.20
6	<0.04	0.040	<0.04	<0.04	<0.04			--				<0.04	--
7	<0.04	0.040	0.040	0.045	<0.04			--				<0.04	--
8	<0.04	0.040	0.060	<0.04	<0.04			--				<0.04	--
9	0.190	<0.04	0.040	<0.04	<0.04			<0.04				<0.04	0.06
10	<0.04	<0.04	0.108	<0.04	<0.04			--				<0.04	--
11	<0.04	0.045	0.070	0.040	<0.04			--				<0.04	--
12	--	0.095	0.088	<0.04	<0.04			<0.04				<0.04	<0.04

TABLE D-20. TOTAL NITROGEN (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	0.32	0.45	0.27	0.31	0.46	0.51	0.34	0.35	0.31	0.29	0.25	0.23	0.25
A comp.	--	--	0.45	0.45	0.24	0.46	0.38	0.38	0.19	0.22	0.35	0.22	0.23
B	0.09	0.20	0.11	0.22	0.08	0.27	0.19	0.23	0.17	0.21	0.18	0.18	0.14
C	0.43	0.60	0.50	0.52	0.49	0.49	0.56	0.55	0.46	0.68	0.49	0.36	0.44
D	1.40	2.12	1.05	1.14	2.17	1.04	1.28	3.00	2.63	0.99	1.75	1.28	2.01
D comp.	--	0.51	0.30	0.90	0.36	--	0.73	1.63	1.32	0.74	--	1.27	0.69
E	>1.10	2.95	5.39	4.99	5.69	6.20	0.68	0.58	0.75	0.82	1.01	1.71	1.17
F	0.10	--	0.10	0.10	0.08	0.18	0.12	0.19	0.13	0.16	0.08	0.07	0.08
G	0.07	0.18	0.14	0.08	0.14	0.18	0.14	0.15	0.06	0.20	0.13	0.12	0.06
G comp.	--	--	0.12	0.15	0.16	0.37	0.14	0.16	0.01	0.31	0.16	0.09	0.04
H	0.08	--	0.11	0.11	0.08	0.20	0.16	0.12		0.20	0.25	0.16	--
1	0.37	--	0.13	0.19	0.09			0.18				0.17	0.11
2	0.49	0.52	0.11	0.30	0.54			0.27				0.81	1.29
3	0.10	0.15	0.05	0.10	0.09			0.12				0.11	0.16
4	0.08	0.08	0.05	0.02	0.07			0.16				0.19	0.11
5	0.38	--	0.18	1.05	0.40			0.20				1.01	0.63
6	0.05	0.10	0.02	0.04	0.03			--				0.04	--
7	0.05	--	0.04	0.05	0.08			--				0.06	--
8	0.06	--	0.12	0.08	0.10			--				0.11	--
9	0.33	--	0.05	0.07	0.15			0.17				0.27	0.11
10	0.03	--	0.19	0.03	0.14			--				0.04	--
11	0.40	--	0.15	0.04	0.03			--				0.02	--
12	--	0.22	0.21	0.10	0.11			0.18				0.05	--

TABLE D-21. SILICA (mg/ℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	16.3	11.3	11.3	11.3	10.9	11.7	10.9	11.4	11.2	11.1	10.8	11.5	11.2
A comp.	--	10.7	9.1	11.2	11.4	12.0	11.2	11.3	11.1	11.4	10.8	11.3	10.8
B	18.5	13.7	13.2	12.8	12.5	13.8	12.8	13.0	13.2	13.1	12.9	12.8	13.0
C	16.2	10.9	11.5	11.6	11.1	12.0	11.1	10.9	11.0	11.4	11.3	11.5	11.2
D	19.3	13.4	13.5	13.2	13.5	14.3	13.5	13.6	13.5	13.7	13.5	13.9	13.5
D comp.	--	13.2	13.0	13.3	13.3	--	13.5	13.7	13.9	13.5	--	13.8	13.5
E	19.3	12.2	12.6	12.5	13.0	13.2	13.7	13.9	13.8	14.0	14.2	15.2	14.2
F	17.7	12.2	12.2	12.0	14.2	12.8	12.0	12.1	12.0	12.2	12.0	12.3	12.1
G	19.3	13.7	13.6	13.7	11.8	14.7	13.7	14.5	14.0	14.1	13.7	14.4	14.1
G comp.	--	13.9	13.6	13.7	13.6	15.0	13.7	13.9	14.0	14.2	13.9	14.5	14.1
H	19.2	13.6	13.7	13.5	13.5	14.4	13.7	14.0	--	14.0	13.9	14.2	--
1	7.8	0.2	5.4	0.4	0.3			0.2				2.9	0.66
2	0.2	0.2	0.4	0.3	0.7			0.5				0.8	0.59
3	<0.1	0.1	0.1	0.2	0.2			0.1				0.1	0.10
4	<0.1	<0.1	0.1	0.4	0.2			0.2				0.1	0.15
5	0.4	0.3	0.5	0.4	0.7			0.7				1.3	1.74
6	<0.1	0.1	0.1	0.2	0.1			--				0.1	--
7	<0.1	0.1	0.1	0.2	<0.1			--				0.1	--
8	0.2	0.7	0.5	0.7	0.3			--				0.6	--
9	15.8	0.6	1.8	1.3	1.1			0.4				2.7	4.00
10	<0.1	0.2	0.1	0.2	<0.1			--				0.2	--
11	<0.1	0.3	0.1	0.2	<0.1			--				0.14	--
12	0.8	1.6	0.9	1.9	1.2			0.9				0.08	1.54

TABLE D-22. TOTAL COLIFORM (NO. ORG./100 mℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	20,000	5,100	5,400	11,800	27,000	17,000	4,000	24,000	20,000	2,700	3,000	1,800	22,000
A comp.	--	70,000	--	10,600	13,000	2,700	11,000	500	4,500	4,600	38,000	2,400	7,000
B	10,000	5,200	5,900	70,000	17,000	6,100	5,500	2,500	300	4,200	<100	2,500	3,500
C	7,300	4,300	10,000	9,200	16,000	4,800	7,200	60,000	100	<100	11,000	25,000	1,300
D	180,000	100,000	130,000	--	240,000	21,000	14,000	86,000	70,000	46,000	23,000	37,000	250,000
D comp.	--	10,000	--	50,000	66,000	--	64,000	67,000	18,000	27,000	--	80,000	38,000
E	30,000	4,400	50,000	20,000	140,000	3,100	36,000	600	21,000	<100	13,000	20,000	48,000
F	4,900	5,000	3,700	10,300	4,300	5,100	4,600	400	100	2,400	2,200	2,000	7,000
G	7,800	6,800	8,300	8,300	5,000	2,700	8,000	8,000	1,600	2,200	500	600	13,000
G comp.	--	1,400	--	4,700	13,000	4,500	4,000	<100	4,600	5,000	200	2,100	32,000
H	5,300	4,300	3,500	11,500	13,000	2,700	9,700	600	--	2,900	4,000	1,500	--
1	8,400	<10	600	8	<10	--	--	<2	--	--	--	300	200
2	470	50	20	140	10	--	--	<2	--	--	--	400	4
3	5	<2	<2	8	2	--	--	2	--	--	--	<2	<2
4	2	<2	<2	<2	<2	--	--	<2	--	--	--	<2	<2
5	28	4	4	2	20	--	--	18	--	--	--	500	500
6	--	--	--	--	--	--	--	--	--	--	--	--	--
7	--	--	--	--	--	--	--	--	--	--	--	--	--
8	--	<2	<2	<2	<2	--	--	--	--	--	--	--	--
9	4,200	<10	10	10	40	--	--	4	--	--	--	6	4,700
10	--	--	--	--	--	--	--	--	--	--	--	--	--
11	<2	<2	<2	<2	<2	--	--	--	--	--	--	<2	--
12	6	--	<2	8	<10	--	--	4	--	--	--	<2	<2

TABLE D-23. FECAL COLIFORM (NO. ORG./100 mℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/10	9/17	9/24	10/01	11/05
A	300	480	700	240	--	2,000	4,200	1,900	1,000	1,000	2,100	800
A comp.	--	250	13,300	--	650	4,000	1,400	4,500	3,400	1,700	350	400
B	2,300	400	1,300	690	<100	1,100	9,000	40	33,000	20	2,600	<100
C	70	80	400	60	--	2,100	1,300	70	50	170	370	<10
D	30,100	70,000	3,500	2,200	--	7,000	4,000	22,000	31,000	14,000	32,000	2,800
D comp.	--	1,170	3,300	40,000	36,100	--	1,900	5,000	21,000	--	29,000	3,100
E	600	1,800	500	<100	150	--	10,000	4,000	50	4,900	3,000	1,470
F	14	10	280	10	<100	1,200	230	10	800	30	610	640
G	<10	240	2,500	200	--	1,000	1,200	160	2,700	100	200	670
G comp.	--	<10	2,600	<100	400	2,000	6,000	150	300	--	240	300
H	70	20	400	<10	400	900	900	--	5,200	40	350	--
1	940	<10	20	<2	<10	--	--	--	--	--	76	80
2	10	<10	10	<2	<10	--	--	--	--	--	24	2
3	<2	<2	<2	<2	<2	--	--	--	--	--	<2	<2
4	<2	<2	<2	<2	<2	--	--	--	--	--	<2	<2
5	4	<2	<2	<2	<2	--	--	--	--	--	300	82
6	--	--	--	--	--	--	--	--	--	--	--	--
7	--	--	--	--	--	--	--	--	--	--	--	--
8	<2	<2	<2	<2	<2	--	--	--	--	--	<2	--
9	250	<10	<10	6	<10	--	--	--	--	--	<10	1,000
10	--	--	--	--	--	--	--	--	--	--	--	--
11	<2	<2	<2	<2	<2	--	--	--	--	--	<2	--
12	2	34	<2	<2	<10	--	--	--	--	--	<2	18

TABLE D-24. FECAL STREPTOCOCCUS (NO. ORG./100 mℓ)

Station	7/09	7/16	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A	5,100	860	2,100	430	830	650	270	420	330	540	560	580	800
A comp.	--	8,200	5,600	300	600	670	<100	290	340	450	800	790	700
B	10,300	2,200	640	3,400	930	300	900	800	330	1,500	1,500	900	1,000
C	1,700	500	910	1,300	430	420	240	800	50	160	570	300	400
D	110,000	20,000	40,000	2,900	37,000	900	400	1,700	3,500	1,000	140,000	1,300	8,000
D comp.	--	5,000	8,000	10,000	19,000	--	300	29,000	500	500	--	2,400	3,000
E	400	2,300	7,200	500	<100	60	120	110	160	460	2,300	9,000	500
F	590	300	40	300	190	270	420	110	20	370	230	520	580
G	4,100	3,500	200	3,000	400	4,400	1,700	700	240	450	260	230	1,000
G comp.	--	700	840	600	800	47,000	800	30	420	560	240	110	300
H	670	100	110	2,800	760	200	150	50	--	370	260	140	--
1	930	<10	620	<2	200	--	--	<2	--	--	--	12	104
2	24	10	<10	--	<100	--	--	2	--	--	--	82	<2
3	<2	<2	<2	<2	2	--	--	<2	--	--	--	<2	<2
4	<2	<2	<2	<2	<2	--	--	<2	--	--	--	<2	<2
5	<2	<2	<2	<2	134	--	--	12	--	--	--	34	2
6	--	--	--	--	--	--	--	--	--	--	--	--	--
7	--	--	--	--	--	--	--	--	--	--	--	--	--
8	<2	<2	<2	<2	<2	--	--	--	--	--	--	2	--
9	310	<10	<2	<2	<100	--	--	2	--	--	--	2	300
10	--	--	--	--	--	--	--	--	--	--	--	--	--
11	<2	<2	<2	<2	<2	--	--	--	--	--	--	<2	--
12	4	88	2	36	<100	--	--	<2	--	--	--	<2	4

APPENDIX E. DEPARTMENT OF HEALTH DATA

TABLE E-1. STATION A

Parameter	Collection Dates												
	7/16	7/18	7/30	Composite 7/30	9/03	Composite 9/03	10/01	Composite 10/01	Composite 10/02	DOH 8/19	Dry Wt. Sediments µg/g	11/05	Composite 11/06
Temperature °C	27.5	27.0	29.0	29.0	27.0		28.0		27.0				
pH	8.0	7.8	7.0	7.1	7.9		7.9		8.0				
Turbidity JTU	2.5		1.4	3.1	1.8	1.3	1.4		1.4			0.7	
Conductivity			215.8	197.2	198.6	199.1	19480		19660			206	
Settleable Sol. mℓ/ℓ	<1		<1		ND		<1						
SS mg/ℓ	7.8	6.9	5.0	3.0	2.7	2.6	2.0					1.0	4.1
BOD mg/ℓ			<2	<2			<2					<2	
NO_2+NO_3-N mg/ℓ	0.20	0.20	0.15	0.21	0.15	0.02	0.49		0.10			0.23	0.25
Kjeldahl N mg/ℓ	0.15	0.16	0.10	0.22	0.32	0.17	0.08		0.16			0.11	0.15
Total N mg/ℓ	0.35	0.36	0.25	0.43	0.47	0.19	0.57		0.26			0.34	0.40
Cl^- mg/ℓ	20	20	21	21	20	20	20		20			21	390
Total P mg/ℓ	0.027	0.010	0.029	0.037	0.040	0.040	0.019		0.022			0.021	0.028
Total Coli. MPN	11		24000	7900	7900	7900	7900	35000					
Fecal Coli. MPN	11		790	790	1300	3300	1300	2100					
Fecal Strep. MPN	1600				1100	2200						2400	660
Cadmium ppm	<0.001	<0.001	0.001	0.001	ND	ND	ND	ND			3.8*	ND	ND
Chromium ppm	0.008	0.022	0.004	0.004	ND	ND	ND	0.005			370*	0.004	0.006
Lead	<0.001	<0.090	0.003	0.002	0.001	ND	ND	ND			320*	ND	0.001
Mercury ppm	<0.0002	<0.0002	<0.0002	<0.0002	ND	ND	ND	ND			0.67*	0.0002	0.0006
Copper ppm	0.003	0.004	0.002	0.004	0.003	0.007	ND	ND			530*	ND	0.002
Zinc ppm	0.001	0.001	0.001	0.001	ND	ND	ND	ND			370*	ND	0.004
Ammonia mg/ℓ	0.05	0.05	0.05	0.05	ND	ND	ND		ND			ND	ND
Silica mg/ℓ	23	25	27	26	33.6	26.1	25.7		25.3			15	22.9
MBAS mg/ℓ			0.002		ND							ND	ND
Lindane ppb										ND			
Dieldrin ppb										ND			
DDT ppb										ND			
Chlordane, α ppb										ND			
Chlordane, γ ppb										ND			
PCB ppb										ND			
PCP ppb										ND			
Nickel ppm							0.004	0.020			230*	ND	0.005
Arsenic ppm											4.6*		
Iron ppm											5700*		

NOTE: ND = nondetectable. *Sediment parameters in ppb.

TABLE E-2. STATION D

Parameter	Collection Dates 7/16	7/18	7/30	7/31	9/03	Composite 9/03	Composite 9/04	10/01	Composite 10/01	11/05	Composite 11/05
Temperature °C	27.0	27.0	29.0	26.0	30.0		15.0	28.0			
pH		7.3	7.0	7.5	7.3		6.4	7.3			
Turbidity JTU	4.6		2.8	3.5	5.2		5.8	3.2		30	
Conductivity			185.9	183.7	184.4		164.8	17460		197	166
Settleable S. mℓ/ℓ	<1		<1		ND			<1		1.3	
SS mg/ℓ	11	3.1	8.5	24	13		82	15		7.4	36
BOD mg/ℓ			3.9					2	<2	4.0	<2
NO_2+NO_3-N mg/ℓ	0.31	0.56	0.45	0.32	0.48		0.42	0.59	0.51	0.46	0.38
Kjeldahl N mg/ℓ	2.1	0.30	0.56	0.49	2.0		1.4	0.83	0.88	2.50	0.62
Total N mg/ℓ	2.4	0.86	1.01	0.81	2.5		1.8	1.4	1.4	3.0	1.00
Cl^- mg/ℓ	17	17	18		17		16	17		18	
Total P mg/ℓ	0.350	0.147	0.264	0.243	0.377		0.332	0.196	0.098	0.993	0.215
Total Coli. MPN	92000		22000		54000	35000	23000	35000	24000		
Fecal Coli. MPN	28000		22000		35000	24000	23000	35000	24000		
Fecal Strep. MPN	>2400				240000					7200	2500
Cadmium ppm	<0.001	<0.001	0.001	<0.001	ND		ND	0.005		ND	ND
Chromium ppm	0.007	0.016	0.010	0.002	ND		ND	0.003		0.006	0.006
Lead ppm	<0.001	<0.001	<0.001	0.001	ND		ND	ND		0.001	0.003
Mercury ppm	0.0002	<0.0002	<0.0002	<0.0002	ND		ND	ND		0.001	0.0009
Copper ppm	0.005	0.004	0.001	0.002	0.005		0.005	ND		0.006	0.008
Zinc ppm	<0.001	<0.001	<0.001	<0.001	ND		ND	ND		0.014	0.005
Ammonia mg/ℓ	0.49	<0.05	0.35	0.14	0.94		0.26	0.50	0.4	0.41	ND
Silica mg/ℓ	27	29	31	29	31		30.9	28.0	30.9	23.1	
MBAS mg/ℓ			<0.002		ND					ND	ND
Nickel ppm								0.005		0.008	0.005

NOTE: ND = nondetectable.

TABLE E-3. STATION G

Parameter	Collection Dates									
	7/16	7/18	7/30	Composite 7/30	9/03	Composite 9/03	10/01	Composite 10/01	11/05	Composite 11/05
Temperature °C	27.5	27.0	29.0	29.0	29.0					
pH	7.5	7.6	7.0	7.1	7.6				7.8	
Turbidity JTU	4.2		3.5	3.9	4.7	6.2	5.7		5.4	
Conductivity			207.8	219.4	203.7	200.5	18770		198	196
Settleable S. mℓ/ℓ	<1		<1		ND		<1		<1	
SS mg/ℓ	4.2	2.7	4.6	1.8	1.7	1.9	3.0		3.4	2.4
BOD mg/ℓ			<2	20			<2	<2	<2	<2
NO_2+NO_3-N mg/ℓ	0.02	0.68	0.07	0.45	0.03	0.03	0.03	ND	0.04	0.03
Kjeldahl N mg/ℓ	0.16	0.11	<0.05	0.12	0.12	0.18	ND		0.12	0.11
Total N mg/ℓ	0.18	0.79	0.07	0.52	0.15	0.21	0.03		0.16	0.14
Cl^- mg/ℓ	21	27	21	22	20	20	21		22	
Total P mg/ℓ	0.028	0.018	0.029	0.037	0.037	0.039	0.008		0.031	0.025
Total Coli. MPN	7900		79	13000	13000	2300	1100			
Fecal Coli. MPN	330		79	230	790	230	49			
Fecal Strep. MPN	130				330	1700			480	460
Cadmium ppm	<0.001	0.009	0.001	0.001	ND	ND	ND	ND	ND	ND
Chromium ppm	0.020	0.023	0.011	0.005	ND	ND	0.003	ND	0.010	0.011
Lead ppm	<0.001	0.050	0.001	0.001	ND	ND	ND	ND	0.002	0.003
Mercury ppm		<0.0002	<0.0002	0.0006	ND	ND	ND	ND		0.004
Copper ppm	0.004	0.064	0.001	<0.001	0.002	0.002	ND		0.005	0.004
Zinc ppm	<0.001	0.019	<0.001	<0.001	ND	ND	ND	ND	ND	ND
Ammonia mg/ℓ	6.05	<0.05	<0.05	<0.05	ND	ND	ND	ND	ND	0.08
Silica mg/ℓ	26	29	32	30	32.2	31.9	32.4		32.0	29.4
MBAS mg/ℓ			<0.002		ND				ND	ND
Nickel ppm	<0.0002						0.006	ND	0.008	0.004

NOTE: ND = nondetectable.

TABLE E-4. STATION 1

Parameter	9/03	10/01	DOH 8/19	11/05
Temperature	25.0	28.8		
pH	8.0	8.2		8.2
Turbidity JTU	3.0	2.4		2.4
Conductivity	47,890	34,980		44,800
Settleable S. mℓ/ℓ	ND	<1		
SS mg/ℓ	6.7	13		17.0
NO_2+NO_3-N mg/ℓ	0.01	0.03		0.02
Kjeldahl N mg/ℓ	0.13	0.29		0.30
Total N mg/ℓ	0.14	0.32		0.32
Cl^- mg/ℓ	20,120	14,000		8,570
Total P mg/ℓ	0.039	0.050		0.052
Total Coli. MPN	2	330		
Fecal Coli. MPN	>2	79		
Fecal Strep. MPN	12			47
Cadmium ppm	ND	ND		ND
Chromium ppm	ND	0.006		0.006
Lead ppm	ND	ND		0.004
Mercury ppm	ND	0.0002		0.0005
Copper ppm	0.008	ND		0.006
Zinc ppm	ND	ND		0.007
Ammonia mg/ℓ	ND	ND		ND
Silica mg/ℓ	ND	5.97		ND
Salinity ‰	34.71	26.05		32.63
Lindane ppb			ND	
Dieldrin ppb			ND	
DDT ppb			ND	
Chlordane, α ppb			ND	
Chlordane, γ ppb			ND	
PCB ppb			ND	
Nickel ppm		0.001		0.006

NOTE: ND = nondetectable.

TABLE E-5. STATION 2

Parameter	Collection Dates 7/16	7/30
Temperature °C	27.5	29.0
pH	8.2	8.0
Turbidity JTU	3.8	3.5
Conductivity	49,890	51,900
Settleable S. mℓ/ℓ	<1	<1
SS mg/ℓ	14	12
NO_2+NO_3-N mg/ℓ	0.03	<0.01
Kjeldahl N mg/ℓ	0.62	0.57
Total N mg/ℓ	0.65	0.57
Cl^- mg/ℓ	20,250	20,000
Total P mg/ℓ	0.175	0.128
Total Coli. MPN	13	130
Fecal Coli. MPN	5	2
Fecal Strep. MPN	14	5
Cadmium ppm	<0.001	<0.001
Chromium ppm	0.029	0.005
Lead ppm	0.002	<0.002
Mercury ppm	<0.0002	<0.0002
Copper ppm	0.004	<0.002
Zinc ppm	<0.001	<0.001
Ammonia mg/ℓ	0.15	0.43
Silica mg/ℓ	0.24	0.73
Salinity ‰	34.628	

TABLE E-6. STATION 9

Parameter	Collection Dates					
	7/16	7/30	9/03	10/01	DOH 8/19	11/05
Temperature °C	27.5	30.0	27.0	28.5		
pH	8.2	8.0	8.2	8.1		8.0
Turbidity JTU	2.2	5.9	5.8	17		4.4
Conductivity	50,506	48,920	47,450	38,140		36,200
Settleable S. mℓ/ℓ	<1	<1	ND	<1		
SS mg/ℓ	13	21	13	13		17.0
NO_2+NO_3-N mg/ℓ	<0.01	0.08	ND	ND		0.08
Kjeldahl N mg/ℓ	0.24	0.24	0.31	0.26		0.30
Total N mg/ℓ	0.24	0.32	0.31	0.26		0.38
Cl^- mg/ℓ	19,530	14,525	19,740	15,050		15,000
Total P mg/ℓ	0.022	0.044	0.040	0.020		0.760
Total Coli. MPN	5	27	33	49		
Fecal Coli. MPN	2	13	2	49		
Fecal Strep. MPN	2	<2	<2			2,900
Cadmium ppm	<0.001	<0.001	ND	ND		0.002
Chromium ppm	0.032	0.005	ND	0.005		0.011
Lead ppm	<0.002	<0.002	ND	ND		0.005
Mercury ppm	<0.0002	<0.0002	ND	0.0002		0.0020
Copper ppm	0.004	0.002	0.005	ND		0.005
Zinc ppm	<0.001	<0.001	ND	ND		0.010
Ammonia mg/ℓ	0.07	<0.5	ND	ND		ND
Silica mg/ℓ	0.56	2.8	ND	5.31		9.51
Salinity ‰	35.025		34.31	28.67		25.75
Lindane ppb					ND	
Dieldrin ppb					ND	
DDT ppb					ND	
Chlordane, α ppb					ND	
Chlordane, γ ppb					ND	
PCB ppb					ND	
PCP ppb					ND	
Nickel ppm				ND		0.005

NOTE: ND = nondetectable.

TABLE E-7. STATION 12

Parameter	Collection Dates				
	7/16	7/30	9/03	10/01	11/05
Temperature °C	27.5	30.0	26.0	28.0	
pH	8.2	8.1	8.1	8.2	8.2
Turbidity JTU	3.4	9.1	17	4.0	4.5
Conductivity	45,160	42,910	45,330	44,750	42,600
Settleable S. mℓ/ℓ	<1	<1	ND	<1	
SS mg/ℓ	164	55	17	33	17
NO_2+NO_3-N mg/ℓ	<0.01	0.02	ND	ND	0.02
Kjeldahl N mg/ℓ	0.42	0.37	0.39	0.14	0.30
Total N mg/ℓ	0.42	0.39	0.39	0.14	0.32
Cl^- mg/ℓ	16,630	16,392	18,240	18,070	19,500
Total P mg/ℓ	0.118	0.084	0.086	0.013	0.018
Total Coli. MPN	790	490	49	7	
Fecal Coli. MPN	33	33	23	2	
Fecal Strep. MPN	4	49	2		20
Cadmium ppm	<0.001	<0.001	ND	ND	ND
Chromium ppm	0.041	0.004	ND	0.003	0.022
Lead ppm	<0.002	<0.002	ND	0.005	ND
Mercury ppm	<0.0002	<0.0002	ND	ND	0.004
Copper ppm	0.012	0.002	0.002	ND	0.003
Zinc ppm	<0.001	<0.001	ND	ND	ND
Ammonia mg/ℓ	0.10	<0.05	ND	ND	ND
Silica mg/ℓ	6.9	4.6	1.86	<1	2.03
Salinity ‰	30.440	24.940	37.56	34.27	30.81
Nickel ppm				ND	0.004

NOTE: ND = nondetectable.

APPENDIX F. ORGANOCHLORINE PESTICIDES IN WATER

Comp.	α Chlordane	γ Chlordane	Dieldrin	PCP	PCB
	----nanograms per liter (parts per trillion)----				
07/18/A	3.3	4.8	4.0		ND
07/24/A	3.9	1.6	4.2	75.2	ND
07/30/A	1.0	0.8	2.7	41.6	ND
08/06/A	1.1	2.0	2.9	40.9	ND
08/27/A	3.1	2.5	4.0	279.7	ND
09/03/A	1.2	0.8	2.3	27.1	ND
09/10/A	0.9	0.6	2.5	17.7	ND
10/02/A	1.0	0.8	2.2	77.5	ND
07/18/D	ND	3.7	1.4		ND
07/31/D	1.3	1.1	1.2	176.7	ND
08/06/D	1.0	0.8	0.8	168.9	ND
08/27/D	1.2	1.0	0.7	91.7	ND
09/04/D	1.3	0.7	0.8	28.1	ND
09/10/D	0.9	0.7	0.7	171.1	ND
07/19/G	1.8	1.9	3.1		ND
07/25/G	1.1	2.2	4.5	351.4	ND
07/30/G	0.7	0.7	1.3	331.8	ND
08/06/G	1.0	1.3	0.6	168.9	ND
08/20/G	0.9	0.8	0.9	283.0	ND
08/27/G	0.9	0.7	0.7	479.8	ND
09/03/G	1.2	2.3	1.3	224.4	ND
09/10/G	0.4	0.7	0.7	118.9	ND
09/17/G	0.9	1.0	1.0	262.7	ND
07/09/A	4.5	4.5	12.9		ND
B	4.9	3.1	9.3		ND
C	1.5	1.7	1.5		ND
D	1.8	1.4	1.9		ND
E	3.4	2.4	6.6		ND
F	4.6	2.7	1.0		ND
G	5.4	0.9	0.8		ND
H	ND	1.0	0.9		ND
07/16/A	4.3	5.2	8.5		ND
B	5.1	5.3	17.9		ND
C	3.1	3.8	2.1		ND
D	3.5	3.8	ND		ND
E	4.0	3.6	5.9		ND
F	ND	1.8	<0.5		ND
G	2.2	0.8	<0.5		ND
H	4.5	1.5	0.8		ND
07/23/A	5.8	3.2	11.1	16.9	
B	3.2	4.2	12.8	41.2	
C	3.8	2.5	4.3	75.8	
D	2.9	2.1	<0.5		ND
E	1.8	1.9	5.1		ND
F	1.5	1.3	0.9		ND
G	0.9	1.3	0.9		ND
H	1.7	0.6	1.3		ND

NOTE: ND = nondetectable.

APPENDIX F. Continued

Comp.	α Chlordane	γ Chlordane	Dieldrin	PCP	PCB
	----nanograms per liter (parts per trillion)----				
07/30/A	5.0	2.9	8.6	123.9	
B	7.2	9.1	17.1	83.4	
C	2.6	2.0	3.0	53.8	
D	1.1	1.0	0.6	218.3	
E	3.1	ND	4.4	49.3	
F	1.2	1.0	1.2	34.5	
G	0.7	0.8	0.8	53.6	
H	<0.5	0.6	0.7	11.5	
08/06/A	15.3	6.6	10.6	71.6	
B	5.0	2.9	12.4	<10 ng	
C	2.2	1.9	3.3	55.3	
D	1.1	0.7	1.2	95.9	
E	2.9	1.6	7.9	95.6	
F	0.6	1.1	1.0	72.6	
G	1.2	1.4	4.1	28.2	
H	1.5	1.5	0.9	31.9	
07/09/01	4.5	4.5	8.8		ND
02	4.3	3.9	2.7		ND
03	5.3	3.5	1.0		ND
05	1.1	1.3	1.1		ND
09	ND	1.6	3.7		ND
12	ND	1.9	1.3		ND
07/16/01	1.8	1.0	1.2		ND
02	1.5	2.2	0.8		ND
03	1.5	1.0	0.8		ND
05	4.9	1.9	1.8		ND
09	1.0	1.9	0.6		ND
12	1.5	0.9	0.7		ND
07/23/01	0.9	0.7	2.7	378.5	
02	1.1	1.4	1.3		ND
03	1.1	0.8	<0.5		ND
05	2.5	1.9	1.6	72.0	
09	<0.5	0.8	1.9		ND
12	1.2	1.5	1.8		ND
07/30/01	1.3	1.0	1.1	36.9	
02	1.8	1.4	1.6	85.7	
03	2.4	1.5	1.6	ND	
05	1.9	2.0	2.2	79.9	
09	1.2	1.1	1.6	15.8	
12	0.6	<0.5	0.8	82.5	
08/06/01	1.7	1.8	1.6	58.1	
02	1.4	1.6	1.1	22.7	
03	1.5	1.5	1.4	<10	
05	1.5	1.2	1.1	77.7	
09	0.8	1.0	1.1	15.9	

NOTE: ND = nondetectable.

APPENDIX G. HEAVY METALS IN WATER

Station	Cd (ppm)										
	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A Comp.	.005	<.005	<.005	--	--	<.005	<.005	--	<.005	<.005	--
D Comp.	--	<.005	<.005	--	<.005	<.005	<.005	<.005	--	--	<.005
G Comp.	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
1	<.005	.009	.006			.006				<.005	.008
9	<.005	<.005	<.005			.008				.006	<.005
12	.010	<.005	<.005			.006				.005	<.005
A	<.005	<.005									
B	<.005	<.005									
C	<.005	<.005									
D	<.005	<.005									
E	<.005	<.005									
F	<.005	<.005									
G	<.005	<.005									
H	<.005	<.005									
2	.010	<.005									
3	.009	--									
5	.009	<.005									
	Cr (ppm)										
A Comp.	.010	<.005	<.005	--	--	<.005	<.005	--	<.005	<.005	--
D Comp.	--	<.005	<.005	--	.006	.006	.006	<.005	--	--	<.005
G Comp.	.010	<.005	<.005	<.005	.034	.008	.020	<.005	.009	<.005	<.005
1	.021	.045	.043			<.020				<.020	.040
9	.025	.038	.042			.040				<.020	<.020
12	.027	.038	.023			.040				<.020	<.020
A	.041	<.005									
B	<.005	<.005									
C	<.005	.010									
D	.005	<.005									
E	.039	<.005									
F	<.005	<.005									
G	<.005	<.005									
H	<.005	.005									
2	.028	.040									
3	.030	--									
5	.025	.031									

APPENDIX G. Continued

Station	Cu (ppm)										
	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A Comp.	.009	<.005	<.005	--	--	<.005	<.005	--	<.005	<.005	--
D Comp.	--	<.005	<.005	--	<.005	<.005	<.005	<.005	--	--	<.005
G Comp.	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
1	<.010	<.010	.012			.012				<.010	.018
9	.019	<.010	<.010			.015				.011	.010
12	.020	<.010	<.010			.016				.010	<.010
A	<.005	<.005									
B	<.005	<.005									
C	<.005	<.005									
D	<.005	<.005									
E	<.005	<.005									
F	<.005	<.005									
G	<.005	<.005									
H	<.005	<.005									
2	<.010	<.010									
3	<.010	--									
5	<.010	<.010									
	Pb (ppm)										
A Comp.	<.003	<.003	<.003	--	--	<.003	<.003	--	<.003	<.003	--
D Comp.	--	<.003	<.003	--	<.003	<.003	<.003	<.003	--	--	<.003
G Comp.	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003
1	<.003	<.003	<.003			<.003				<.003	<.003
9	.003	.004	<.003			<.003				.004	<.003
12	.003	.003	.003			<.003				<.003	<.003
A	<.003	<.003									
B	<.003	<.003									
C	<.003	<.003									
D	<.003	<.003									
E	<.003	<.003									
F	<.003	<.003									
G	<.003	<.003									
H	<.003	<.003									
2	<.003	<.003									
3	<.003	--									
5	<.003	<.003									

APPENDIX G. Continued

Station	Hg (ppm)										
	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A Comp.	<.003	<.003	<.003	--	--	<.003	<.003	--	<.003	<.003	--
D Comp.	--	<.003	<.003	--	<.003	<.003	<.003	<.003	--	--	<.003
G Comp.	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003
1	<.003	<.003	<.003			<.003				<.003	<.003
9	<.003	<.003	<.003			<.003				<.003	<.003
12	<.003	<.003	<.003			<.003				<.003	<.003
A	<.003	<.003									
B	<.003	<.003									
C	<.003	<.003									
D	<.003	<.003									
E	<.003	<.003									
F	<.003	<.003									
G	<.003	<.003									
H	<.003	<.003									
2	<.003	<.003									
3	<.003	--									
5	<.003	<.003									
	Ni (ppm)										
A Comp.	<.003	<.003	<.003	--	<.003	<.003	<.003	--	<.003	<.003	--
D Comp.	--	<.003	<.003	--	<.003	<.003	<.003	<.003	--	--	<.003
G Comp.	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003
1	<.003	<.003	<.003			<.003				<.003	<.003
9	<.003	<.003	<.003			<.003				<.003	<.003
12	<.003	<.003	<.003			<.003				<.003	<.003
A	<.003	<.003									
B	<.003	<.003									
C	<.003	<.003									
D	<.003	<.003									
E	<.003	<.003									
F	<.003	<.003									
G	<.003	<.003									
H	<.003	<.003									
2	<.003	<.003									
3	<.003	--									
5	<.003	<.003									

APPENDIX G. Continued

Station	Zn (ppm)										
	7/23	7/30	8/06	8/20	8/27	9/03	9/10	9/17	9/24	10/01	11/05
A Comp.	<.005	<.005	<.005	--	--	<.005	<.005	--	<.005	<.005	--
D Comp.	--	<.005	<.005	--	<.005	<.005	<.005	<.005	--	--	<.005
G Comp.	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
1	.006	.007	.012			<.005				<.005	<.005
9	<.005	.007	.008			.013				.005	<.005
12	.005	<.005	<.005			<.005				<.005	<.005
A	<.005	<.005									
B	<.005	<.005									
C	<.005	<.005									
D	<.005	<.005									
E	<.005	<.005									
F	<.005	<.005									
G	<.005	<.005									
H	<.005	<.005									
2	<.005	<.005									
3	<.005	--									
5	<.005	.006									

Section 5. CLASSIFICATION AND ESTABLISHMENT OF WATER AREAS

The following classification of water uses shall apply to the following areas:

A. Coastal Water Areas and Non-Tidal Brackish and Saline Surface Water Areas

1. *Oahu*

(a) *Class AA waters*

Waimanalo Bay from Makapuu Point to the southerly boundary of Kaiona Beach Park and including the waters surrounding Manana and Kaohikaipu Islands.

Kaneohe Bay.

Kahana Bay.

Waialua Bay, from Puaena Point to Kaiaka Point.

The near shore waters along Kaena Point for a distance of 3½ miles towards Mokuleia and 3½ miles towards Makua.

That portion of West Loch, Pearl Harbor, lying north of a tangent drawn from Nichols Point to Loch Point.

Hanauma Bay.

(b) *Class A waters*

That portion of Waimanalo Bay not designated Class AA.

Kailua Bay, from Wailea Point to Mokapu Point.

The near shore waters between Mokapu Point and Pyramid Rock.

The near shore waters between Makalii Point and Laie Point.

Laie Bay.

All coastal waters and non-tidal brackish and saline surface waters not included in any other class.

(c) *Class B waters*

Kaneohe Bay small boat harbor adjacent to Kaneohe Yacht Club.

Kaneohe Marine Corps Air Station small boat harbor and pier area.

Kewalo Basin.

Ala Wai Boat Harbor.

Pokai Bay small boat harbor.

Haleiwa small boat harbor.

Keehi Lagoon marina areas.

Heeia-Kea small boat harbor.

(b) *Class A waters*

The near shore waters from the northern boundary of Kawaihae Harbor to the southern boundary of Mahukona Harbor.

The near shore waters from Kauilii Point to the westerly boundary of Hilo Harbor.

All coastal waters and non-tidal brackish and saline surface waters not included in any other class.

(c) *Class B waters*

Honaupo Bay.

Kealakekua Bay.

Keauhou Bay.

Kailua Bay.

Honokahau Bay.

Mahukona Harbor.

Hilo Harbor.

Kawaihae Harbor.

8. *All Other Islands of the State*

(a) *Class AA waters*

All near shore waters of all islands not classified in Section 5.A.1. through 7.

(b) *Class A waters*

All off-shore waters and non-tidal brackish and saline surface waters not included in any other class.

B. Fresh Water Areas

1. *Class 1 waters*

All sources of fresh surface waters on all islands whether publicly or privately owned, used for domestic, culinary, or food processing purposes.

2. *Class 2 waters*

All fresh surface waters included in "State waters" as defined by Chapter 37, Public Health Regulations, not included in Class 1.

Section 6. WATER QUALITY STANDARDS

A. Basic Standards Applicable to all Water Areas

All waters shall be free of substances attributable to domestic, industrial, or other controllable sources as follows:

1. Materials that will settle to form objectionable sludge and bottom deposits;

SOURCE: State of Hawaii, Department of Health, *Public health regulations*, chap. 37-A (1937).

2. Floating debris, oil, grease, scum, and other floating materials;
3. Substances in amounts sufficient to produce taste or odor in the water or detectable off-flavor in the flesh of fish, or in amounts sufficient to produce objectionable color, turbidity, or other conditions in the receiving waters;
4. High temperature, biocides, pathogenic organisms, toxic, corrosive, or other deleterious substances at levels or combinations sufficient to be toxic or harmful to human, animal, plant or aquatic life or in amounts sufficient to interfere with any beneficial use of the water. As a minimum, evaluation by use of a 96-hour bioassay as described in the most recent edition of *Standard Methods for the Examination of Water and Wastewater* shall be conducted. Survival of test organisms shall not be less than that in controls which utilize appropriate experimental water;
5. Substances and conditions or combinations thereof in concentrations which produce undesirable aquatic life.

All waters shall also be free from soil particles resulting from erosion on land involved in earthwork, such as the construction of public works; highways; subdivisions; recreational, commercial, or industrial developments; or the cultivation and management of agricultural lands. This standard shall be deemed met if it can be shown that the land on which the erosion occurred or is occurring is being managed in accordance with soil conservation practices acceptable to the Director, and that a comprehensive conservation program is being actively pursued, or that the discharge has received the best degree of treatment or control practicable under existing technology. The determination of compliance with the standard shall be made by the Director, consistent with the Hawaii Administrative Procedure Act and the Rules of Practice and Procedure of the Department of Health.

B. Specific Standards Applicable to Particular Water Areas

1. *Microbiological Requirements*	Applicable to:
The median coliform bacteria shall not exceed 70 per 100 ml during any 30-day period nor shall samples exceed 230 per 100 ml at any time.	Class AA
The median coliform bacteria shall not exceed 1000 per 100 ml, nor shall more than 10% of the samples exceed 2,400 per 100 ml during any 30-day period.	Classes A, 1 and 2
Fecal coliform content shall not exceed an arithmetic average of 200 per 100 ml during any 30-day period nor shall more than 10% of the samples exceed 400 per 100 ml in the same time period. For such portion of Class 1 waters from which water is withdrawn for distribution for drinking water or food processing following simple chlorination, the fecal coliform content shall not exceed an arithmetic average of 20 per 100 ml during any calendar month.	
Fecal coliform content shall not exceed an arithmetic average of 400 per 100 ml during any 30-day period nor shall more than 10% of the samples exceed 1000 per 100 ml in the same time period.	Class B

To determine compliance with the above microbiological requirements where a "30-day period" is specified, a minimum of ten samples shall be collected.

2. *pH—Units*	Applicable to:
Not more than ½ unit difference from natural conditions but not lower than 8.0 nor higher than 8.5 from other than natural causes. (Not lower than 7.0 for fresh tidal waters.)	Class AA
Not more than ½ unit difference from natural conditions but not lower than 7.0 nor higher than 8.5 from other than natural causes.	Classes A, B, and 1
Not less than 6.5 nor higher than 8.5.	Class 2

3. *Nutrient Materials*	Applicable to:
Total phosphorus, not greater than 0.020 mg/l.	Class AA
Total phosphorus, not greater than 0.025 mg/l.	Class A
Total phosphorus, not greater than 0.030 mg/l.	Class B
Total phosphorus, not greater than ~~0.20~~ mg/l; except not greater than 0.05/mg/l for waters entering lakes or reservoirs.	Classes 1 and 2
Total nitrogen, not greater than ~~0.10~~ mg/l.	Class AA
Total nitrogen, not greater than 0.15 mg/l.	Class A
Total nitrogen, not greater than 0.20 mg/l.	Class B

4. *Dissolved Oxygen (except from natural causes)*	Applicable to:
Not less than 6.0 mg/l.	Classes AA and 1
Not less than 5.0 mg/l.	Classes A and 2
Not less than 4.5 mg/l.	Class B

5. *Total Dissolved Solids, Salinity, and Currents*	Applicable to:
No changes in channels, in basin geometry of the area, or in freshwater influx shall be made which would cause permanent changes in isohaline patterns of more than ± 10% of naturally occurring variation or which would otherwise affect biological and sedimentiological situation. Total dissolved solids shall not be below 28,000 mg/l from other than natural causes.	Class AA
6. *Temperature*	Applicable to:
Temperature of receiving waters shall not change more than 1.5° from natural conditions.	Classes AA, A, B, 1, and 2
7. *Turbidity*	Applicable to:
Secchi disc or secchi disc equivalent as "extinction coefficient" determinations shall not be altered from natural conditions more than 5% for Class AA or Class 1 waters, 10% for Class A or Class 2 waters, or 20% for Class B waters.	Classes AA, A, B, 1, and 2
8. *Radionuclides*	Applicable to:
Concentrations of radioactive materials shall not exceed minimum concentrations which are feasible to achieve. In no case shall such material exceed the limits established in the 1962 Public Health Service Drinking Water Standards (or later amendments) or 1/30th of the MPCw values given for continuous occupational exposure in the National Bureau of Standards Handbook No. 69. The concentrations in water shall not result in accumulation of radioactivity in plants or animals that result in a hazard to humans or harm to aquatic life.	Classes AA, A, B, 1, and 2
The concentration of radioactive materials present in fresh, estuarine, and marine waters shall be less than those that would require restrictions on the use of organisms harvested from the area in order to meet the Radiation Protection Guides recommended by the Federal Radiation Council.	Classes AA, A, B, and 2

Analyses to determine water quality shall be based on the U.S. Environmental Protection Agency manual entitled "Methods for Chemical Analysis of Water and Wastes," as revised, and "Biological Methods for Measuring the Quality of Water and Wastes," as revised, or as otherwise previously specified or approved by the Director.