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MEMORANDUM

October 7, 1981

To: Dave Wright, N.W. Regional Office, WDOE

From: Timothy A. Determan, Water Quality Investigations Section

Subject: The Effects of Two Sewage Treatment Plant Discharges on Sinclair Inlet Receiving Waters

INTRODUCTION

In response to requests from the Northwest Regional Office of the Department of Ecology, the Marine Unit of WDOE's Water Quality Investigations Section designed and carried out receiving water studies of two sewage treatment plant discharges in Sinclair Inlet. These plants are Bremerton STP No. 2 (Charleston) and Port Orchard STP. The purpose was to characterize the effects of the two discharges on Sinclair Inlet water quality. These projects were performed in association with Class II studies conducted at each plant. The Port Orchard STP Class II study was performed by Abercrombie and Yake (1980) and the Bremerton STP Class II study, (Charleston) by Wright (1981). Detailed descriptions of both plants are found in their documents. A general review of water quality conditions, inlet circulation, biological features, and land use in Sinclair Inlet are discussed by Determan (1980) and summarized below.

Sinclair Inlet is a shallow bay approximately 1-2 km (0.8 mile) wide and 8 km (4.6 miles) long (Figure 1). Depth from mean lower low water (MLLW) varies from 6 to 7.6 m (20 to 25 feet) at the WSW end to over 15.2 m (50 feet) at the east end. Currents in Sinclair Inlet have been shown by field measurements and a physical model of the inlet, to be weak (0.2 to 0.3 knot) with a slow oscillating bi-directional flow giving net transport to the east. Summertime multiple-depth drogue observations and temperature measurements suggest water column stratification. Flushing characteristics and currents appear to be tidally dominated. The weak tidal currents suggest a low rate of tidal exchange in the upper reaches of Sinclair Inlet. The volume of water exchanged each day in Sinclair Inlet has been estimated to be approximately one percent.

A number of small streams enter Sinclair Inlet. Ghorst and Anderson creeks flow into the western end. Ross and Blackjack creeks discharge

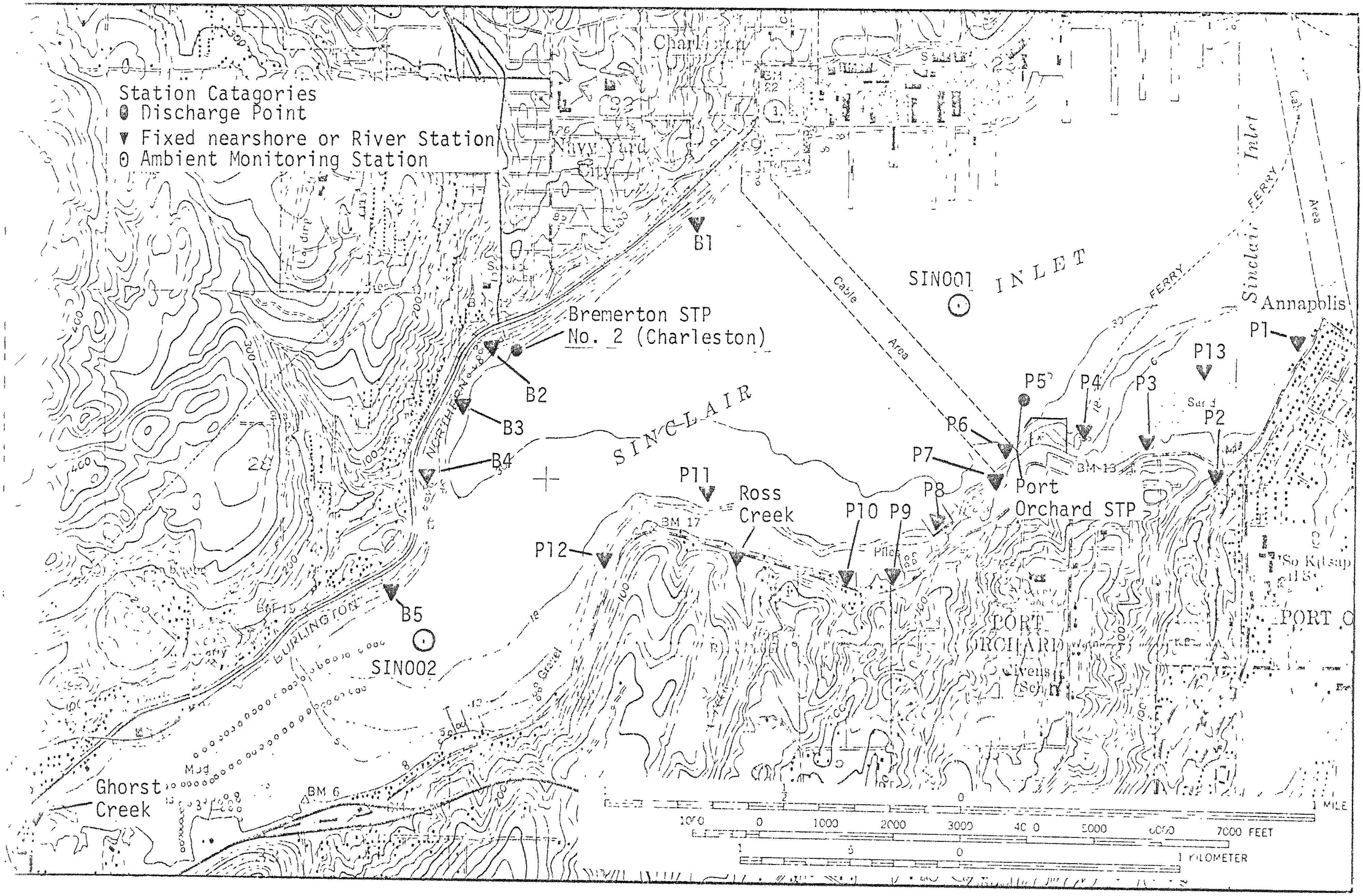


Figure 1. Locations of discharge points, fixed nearshore and river stations on Sinclair Inlet (taken from U.S. Geological Survey maps for Bremerton West and East Quadrangles).

into the eastern compartment near Port Orchard. Many springs and small seeps are seen along the shoreline.

There are seasonal variations in rainfall and wind characteristics. Maximum rainfall occurs during winter months and minimums during the summer. In general, southwesterly winds prevail in fall and winter, while spring and summer months are characterized by northwesterly winds.

The water quality in Sinclair Inlet shows seasonally high fecal coliform and nutrient and low dissolved oxygen levels. Nutrient levels drop during the spring bloom, and remain low throughout the summer. Correspondingly, dissolved oxygen levels generally rise to saturation levels. However, during some periods of algal die-off, decomposers consume dissolved oxygen, resulting in oxygen depletion. During these periods, discharge of additional organic materials such as primarily treated or untreated sewage becomes a risk for marine systems of limited circulation since anoxic conditions could result and cause suffocation of benthic organisms and territorial fish.

Sinclair Inlet currently carries two Water Quality Standards classifications. Waters west of 122°37'W (Retsil) are classified as A while waters to the east are classified as AA waters (DOE, 1980).

Bremerton STP No. 2 presently discharges primarily-treated sewage into lower Sinclair Inlet. The outfall lies at 10 m depth. Sewage is dispersed through 20 diffuser ports spaced 2 m apart. The discharge is located 1.5 km (1 mile) east of the Bremerton Puget Sound Naval Shipyard. Port Orchard STP discharges primary effluent into Sinclair Inlet immediately north of the Port Orchard Marina in about 15 m of water through a 0.6 m (1.5 feet) diameter pipe (Abercrombie and Yake, 1980). The outfall is located approximately 50 m (150 feet) northeast of the marina entrance. Preliminary dye work strongly suggest that the Port Orchard discharge lacks a diffuser or is not operable.

METHODS

Identical methods were used to evaluate the effects of the two discharges. The critical sampling period was assumed to be slack tide when maximum concentrations of effluent would occur. Field sampling surveys were carried out during both low slack and high slack periods for each discharge.

Initially, a 500 ml volume of Rhodamine wt flourescent dye was released into each outfall line. A marker buoy was released together with two 1 m and one 5 m drift drogues when the dye surfaced near the point of offshore discharge. Dilution and dispersion characteristics were measured by tracking these two "effluent markers" for one-hour.

The drift drogues are constructed of black polyethylene sheets supported by 3/4 in. (ID) electrical conduit at top and bottom. The tubing is bolted at their centers. The sheets are held open at a right angle by light weight rope. Each drogue is weighted at the bottom and suspended from a surface float by a light line such that the center of the drift cross was set at the selected depth. The construction of the drogues was modified from Ebbesmeyer and Okubo, 1974 (Fig. 2).

For the purpose of these studies, a mixing zone was arbitrarily defined as the zone within which a mass of marine water moved during a 60-minute period following passage over the discharge point. This concept of a mixing zone fixes time but allows the zone to vary in space according to current movement. In this way, it was hoped that mixing rates could be estimated. On the other hand, DOE (1980a) established effluent dilution zone guidelines for estuaries and marine water that were based on diffuser length, depth, and distance offshore, regardless of the nature of the discharge site or the current velocity and direction. For this study, application of DOE (1980a) did not seem appropriate because variations caused by natural phenomenon such as currents, winds, or discharge rates are not addressed by the guidelines. Also, since the Port Orchard discharge seems to lack a diffuser, it is mathematically impossible to define a dilution zone for this discharge using the DOE guidelines.

Within the mixing zone, sampling strategy called for obtaining a time-series picture of the effluent plume and downstream characterization of dilution and mixing effects as the tagged water mass moved through this zone. This was accomplished by multiple-depth sampling begun at the point of discharge when the injected dye surfaced. Sampling continued at 20-minute intervals as the cloud of dye and the drogues drifted "downstream." During each sampling, bearings were taken of charted landmarks using a Weems and Plath hand bearing compass for later position plotting.

An additional set of surface samples was obtained over the discharge point each time a "downstream" stations was sampled. Four sets of "downstream" multiple depth and three additional discharge surface samples were obtained during each 60-minute drift period.

In order to compare water quality characteristics within the STP mixing zone with surrounding receiving waters, fixed nearshore stations were sampled in conjunction with mixing zone sampling. Most of these stations were associated with probable contamination sources such as small streams, drain pipes, marinas, or shoreside buildings. However, several were located in zones with minimum probability of contamination. These served as controls (Figure 1). In addition to the fixed nearshore stations, samples were also taken at two DOE ambient stations located in the middle of Sinclair Inlet, to provide an overall control.

The higher number of nearshore stations sampled near Port Orchard reflects a greater number of streams and drains, greater intensity of land and water use and greater population along this shore compared to the Charleston area.

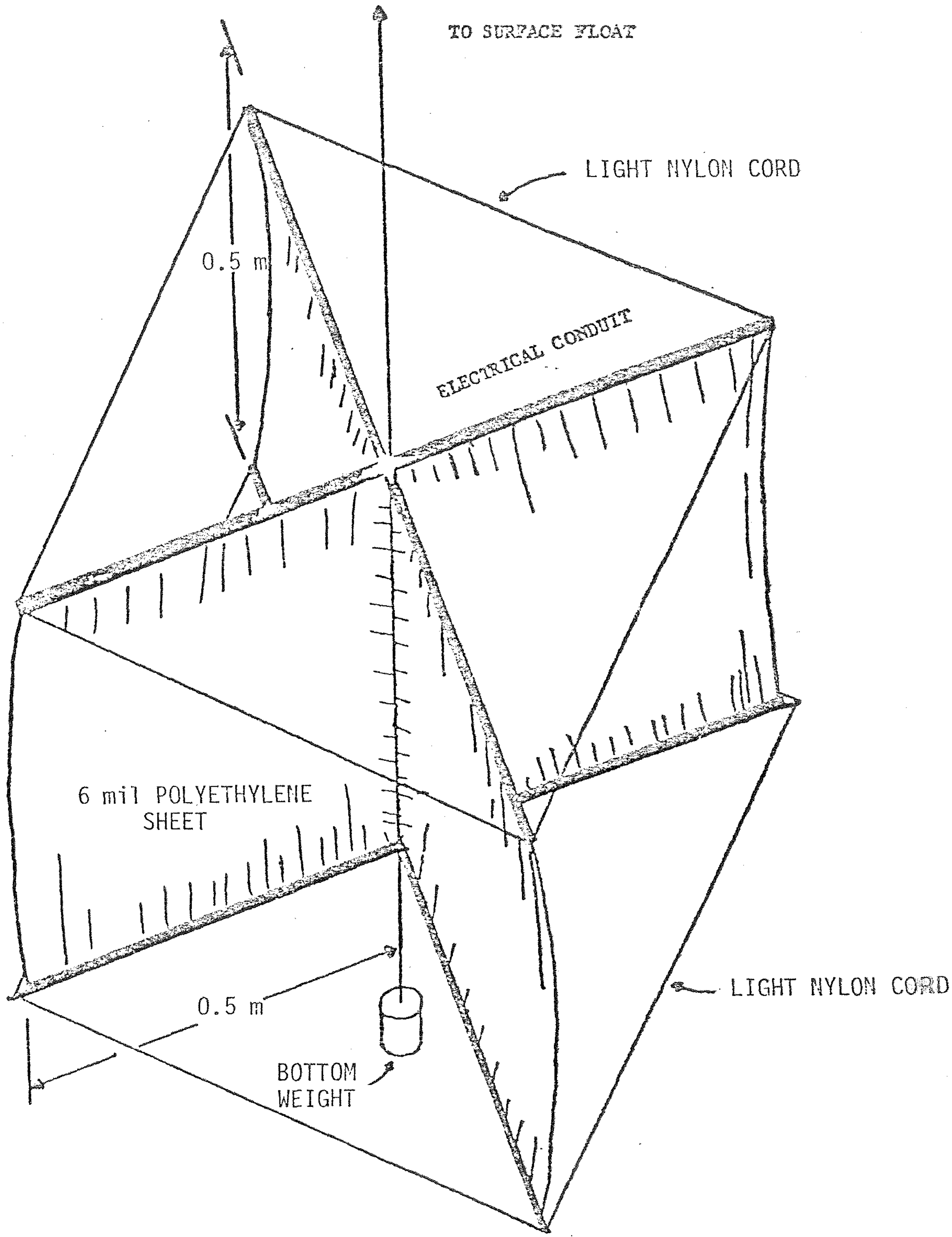


Figure 2. Sketch of drogue used in present study. (adapted from Ebbesmeyer and Okubo, 1974).

A list of parameters and the rationale for sampling each is shown in Table 1. Laboratory analyses were performed by the Department of Ecology Water Quality Laboratory according to methods given in APHA (1976) and EPA (1979).

A messenger-triggered Van Dorn type sampling bottle was used to collect all samples at depth. Fecal coliform samples were also taken from this device. Due to time and equipment constraints, sterilization between sampling was not possible. However, the sampler was thoroughly flushed before encasing each bottle. The data do not suggest cross contamination.

Wastewater flows from each STP were measured with a Manning Dipper flow meter. These results were compared with flows recorded during Class II surveys conducted in association with this study (Abercrombie and Yake, 1980; Wright, personal communication) in order to assure that plant discharges were comparable. During March, the flows of several rivers were measured with a Marsh-McBirney electromagnetic flow meter for use in calculating river discharges. Stream sampling was also performed by taking a series of five aliquots with 50 ml graduated cylinders in order to obtain a representative sample from each stream.

RESULTS AND DISCUSSION

Port Orchard STP

Surveys were conducted off Port Orchard during high slack tide on December 15, 1980 and January 28, 1981. Low slack conditions were evaluated on March 25, 1981. Weather was similar on all occasions with partly sunny skies and limited precipitation. Winds ranged from calm to gentle breeze from the southwest (Beaufort Scale 3; Bowditch, 1966).

The time required for dye released at the treatment plant to appear in Sinclair Inlet surface waters varied by survey as follows:

December 15, 1980	75 minutes
January 28, 1981	47 minutes
March 25, 1981	27 minutes

According to Bill Yake (personal communication), this phenomenon may be due to instantaneous flow fluctuations caused by the periodic release of wastewaters which back up into the city's collection system during grit chamber cleaning.

During the January 28, 1981 survey, a separate small dye cloud appeared in marine waters immediately below the plant and west of a marina companionway (Figure 3). Bill Yake identified this as the discharge point for the plant's grit chamber.

Table 1. Parametric coverage and rationale for measuring each during Bremerton STP No. 2 (Charleston) and Port Orchard STP receiving water studies in Sinclair Inlet.

Parameter	Location	Method	Reason for sampling
1. Temperature (°C)	All receiving water stations	Thermometer	Used with salinity to determine water density; temperature also affects gas soluability and rates of biological processes.
2. Salinity (0/00)	All receiving water stations	Beckman laboratory induction salinometer	Used to trace passage of freshwater through marine waters, mixing rates, an density distribution in water column.
3. Secchi depth (m)	Discharge zone, ambient stations	Secchi disc lowered to depth of disappearance.	Measures water column transparency, light availability and is an estimate of suspended material in water column. Sufficient light is essential to marine plant growth. Excessive suspended mate rial may stress bottom-dwelling plants and animals by interference in filter feeding, and by light reduction, or smothering.
4. Dye (ug/L)	Discharge zone	Turner flourometer	Used as a water movement tracer and gau of dilution and mixing processes downstream from discharge point.
5. Fecal coliform (fc/100 ml)	All stations	APHA (1976); EPA (1979)	Indicator of presence of sewage wastes from humans and other animals.
6. Dissolved O_2 (mg/L; % saturation)	All receiving water stations	Winkler - azide modification (APHA, 1976; EPA, 1979).	Elevated, relatively constant oxygen levels are essential for stable marine communities. Highly variable levels downstream from a source may be indicative of an organic load in excess of th ability of the system to assimilate it.

Table 1. (Continued)

Parameter	Location	Method	Reason for sampling
7. Nutrients (mg/L) NO_3-N, NO_2-N, O-PO_4-P, Total-PO_4-P, NH_3-N	All stations	APHA (1976); EPA (1979)	Inorganic nutrients are most readily available for assimilation by marine plants. Excessive levels with abundant light may lead to massive algae production at the expense of other plants and animals. Ammonia (NH_3-N) is an immediate byproduct of the breakdown of urine and is therefore useful to trace animal wastes in water. Excessive levels of un-ionized ammonia are toxic to aquatic organisms. But toxic levels in marine waters are controversial (EPA, 1976; Thurston et al., 1979). Toxic levels are a function of pH, temperature, and salinity.
8. pH	All stations	Orion digital pH meter	pH affects the carbonic acid-carbon dioxide balance in seawater. pH also affects the activity of unionized ammonia and sulfide. EPA (1976) recommends pH values be within 6.5 to 9.0 pH units.
9. Turbidity (NTU), Total suspended solids (TSS, mg/L)	All receiving water stations	Turbidity: Hach Turbidimeter; TSS: APHA (1975), EPA (1979).	Refer to 3. Secchi disc comments above.
10. Chlorine residual (mg/L)	STP and surface at point of discharge	LaMotte-Palin DPD field test kit (0.1 ppm minimum detectable level).	Chlorine is used as a disinfectant in STP effluent discharges. It is also toxic to marine organisms. EPA (1976) recommends an upper limit of 2.0 ug/L for salmonid fish and 10.0 ug/L for other freshwater and marine organisms. AFS (1979) suggests that 20 ug/L for total oxidants is the best marine criterion at present.

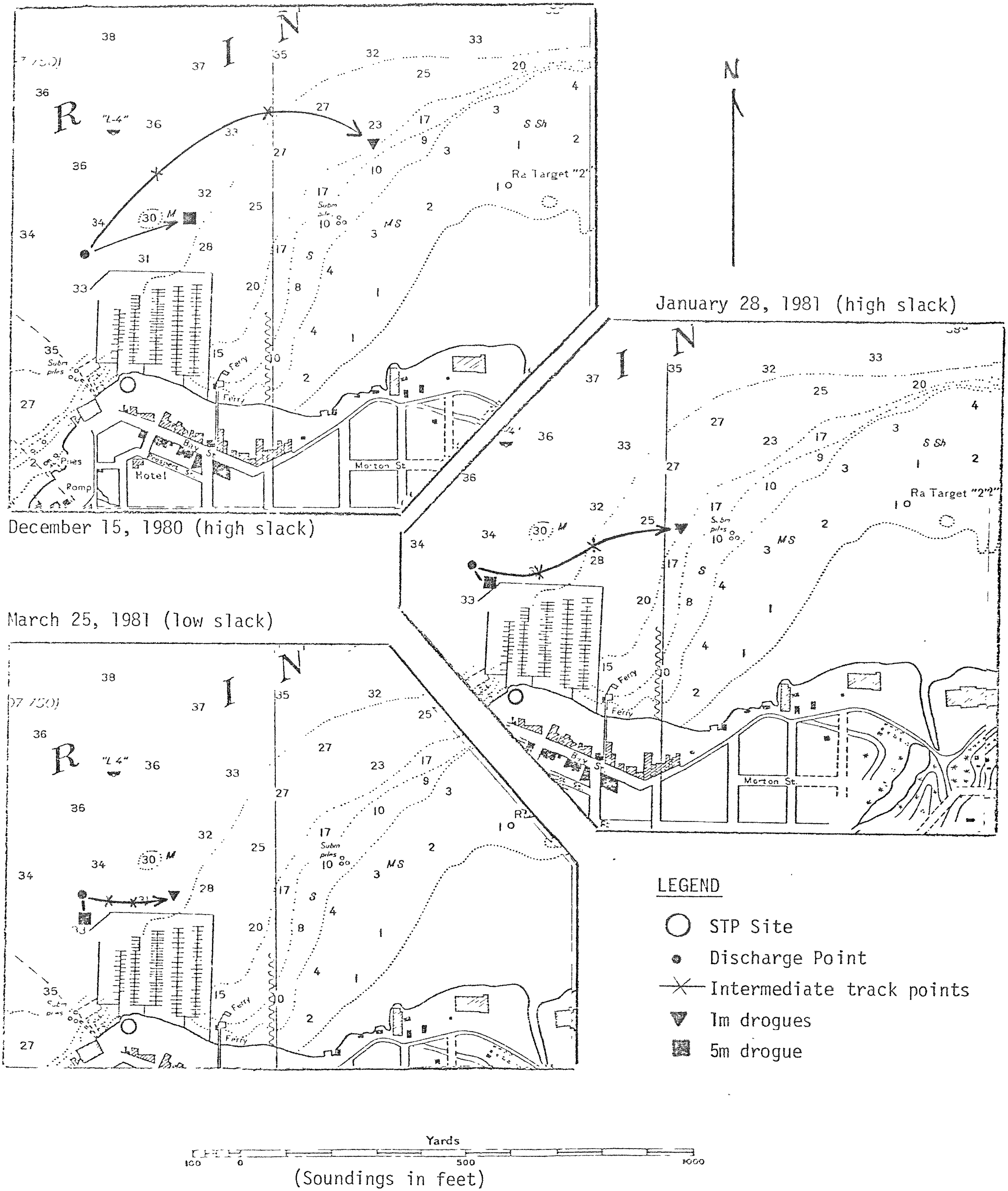


Figure 3. Drogue tracks for high and low slack tidal current states offshore from Port Orchard, Sinclair Inlet after 1-hour drift periods (taken from NOAA Nautical Chart No. 18452).

Figure 3 shows the track lines of the 1 and 5 m drogues during each survey. In general, the 1 m drogue movement coincided with the dye patches. For this reason, the 1 m track line represents both 1 m drogues. In all cases displacement was eastward toward Annapolis. The smallest displacement was observed on March 25 when the low tide sampling was performed. The behavior of the 5 m drogues was substantially different than the 1 m units. Displacement was 15° to 80° eastward of the 1 m drogues and 10 to 30 percent of the 1 m drogue distance during the one-hour survey period. During the March 25 and January 28 surveys the deeper drogues drifted generally toward shore heading for Port Orchard Marina area.

The water quality data for all surveys, stations, and depths at Port Orchard are shown in Tables 2 and 3. Overall averages also are shown for the pooled data for all stations within each category of stations.

Few receiving water parameters showed significant differences by tide or station. During high slack, fecal coliform levels within the mixing zone were slightly less overall compared to the nearshore stations, while ambient station SIN001 was substantially lower. Fecal coliform levels were very low at all stations during the low slack survey. Dissolved oxygen levels were generally high during all surveys. Oxygen samples taken at 10 m within the mixing zone showed the lowest values, particularly during low slack tide. However, these values did not differ greatly from the ambient station. Indeed, all oxygen values were higher in March than in December and January probably due to the seasonal increase in primary production by marine phytoplankton and benthic plants. Temperature and salinity were used to determine density which will be discussed later.

Fecal coliform, ammonia, and dye levels appeared to be the most variable of the data. These values were plotted on Figures 4 and 5 in order to determine whether a predictable mixing rate could be estimated. The fecal coliform data and the dye, however, tended to be unevenly mixed in the water and the ammonia proved to be too unstable to allow a mixing rate estimation. However, the data do suggest advective mixing processes downstream from the discharge point. The plots given in Figures 4 and 5 serve to give a visual comparison of the values and the variability between the station categories.

High slack data (Figure 4) show relatively uniform fecal coliform values at all depths for all stations. Values at 5 m and 10 m at the discharge point show higher levels than those at the same depth elsewhere. Surface fecal coliform levels within the mixing zone were quite comparable. The expected high average over the discharge at the surface was not apparent. These surface values compared favorably to all other stations except for SIN001 surface values. Except for elevated levels at the surface stations closest to the discharge, ammonia and flourescent dye levels are probably not different from other depths and stations within the mixing zone and in the case of ammonia, elsewhere as well.

Table 2. Summary of water quality data collected at Sinclair Inlet and within the mixing zone of the Port Orchard STP c
conditions (December 15, 1980 and January 28, 1981).[1/]

Stn. No.	Depth (m)	Temp. (°C) $\overline{X} \pm s$ (n)	Salinity (in situ, o/oo)[2/] $\overline{X} \pm s$ (n)	Sigma-t[2/] $\overline{X} \pm s$ (n)	Secchi Depth (m) $\overline{X} \pm s$ (n)	Dye (ug/L) $\overline{X} \pm s$ (n)	FC (org per 100 ml) G.M. (n)	D.O. (mg/L) $\overline{X} \pm s$ (n)
STP							4.9 x 10^6(2)	
MIXING ZONE								
A	0	9.06 ± 1.05 (8)	29.85 ± .01 (4)	22.96 ± .01 (4)	4.0 ± .6 (6)	48.6 ± 35.8 (2)	26 (8)	7.56 ± .47
	5	9.11 ± 1.23 (2)	29.94 (1)	23.03 (1)		1.8 ± 1.8 (2)	48 (2)	7.44 ± .37
	10	9.12 ± 1.24 (2)	30.06 (1)	23.54 (1)		.5 ± .7 (2)	15 (2)	7.36 ± .47
B	0	8.73 ± 1.80 (2)	29.80 (1)	22.93 (1)	3.8 ± .6 (2)	6.0 ± 7.1 (2)	18 (2)	7.74 ± .25
	5	9.08 ± 1.27 (2)	29.89 (1)	23.00 (1)		.8 ± .4 (2)	21 (2)	7.59 ± .27
	10	9.11 ± 1.27 (2)	29.98 (1)	23.06 (1)		.5 ± .7 (2)	3 (2)	7.38 ± .34
C	0	8.71 ± 1.82 (2)	29.89 (1)	23.00 (1)	4.4 ± .3 (2)	2.6 ± .8 (2)	16 (2)	7.80 ± .22
	5	9.20 ± 1.12 (2)	29.94 (1)	23.03 (1)		0 (2)	19 (2)	7.70 ± .42
	10	9.17 ± 1.17 (2)	29.96 (1)	23.05 (1)		0 (2)	6 (2)	7.32 ± .62
D	0	8.66 ± 1.91 (2)	29.90 (1)	23.00 (1)	4.4 ± 6 (2)	2.0 (1)	14 (2)	7.78 ± .31
	5	9.00 ± 1.44 (2)	29.82 (1)	22.94 (1)		.8 ± .4 (2)	16 (2)	7.74 ± .37
	10	9.17 ± 1.20 (2)	30.06 (1)	23.54 (1)		0 (2)	6 (2)	7.14 ± .42
OVERALL		9.16 ± 1.04(26)	29.91 ± .09 (15)	23.06 ± .20 (15)			14 (24)	7.55 ± .38
DOE AMBIENT STATION SIN001								
	0	8.70 ± 1.84 (2)	29.32 (1)	22.55 (1)		0 (2)	2 (2)	7.78 ± .25
	5	9.12 ± 1.24 (2)	29.72 (1)	22.85 (1)		0 (2)	14 (2)	7.55 ± .43
	10	9.14 ± 1.17 (2)	29.73 (1)	22.87 (1)		0 (2)	7 (2)	7.39 ± .54
OVERALL		8.99 ± 1.14 (6)	29.49 ± .23 (3)	22.76 ± .18 (3)			6 (6)	7.57 ± .37
NEARSHORE FIXED SURFACE STATIONS								
P1		7.45	29.91 (1)				4 (2)	7.78
P2		8.14 ± .86 (2)	--				49 (2)	10.67
P3		8.90 ± 1.53 (2)	29.84 (1)				12 (2)	7.89 ± .27
P4		8.75 ± 1.78 (2)	29.82 (1)				12 (2)	7.72 ± .17
P5		8.10 ± .71 (2)	29.88 (1)				10 (2)	7.78 ± .03
P6		8.12 ± .47 (2)	29.34 (1)				3 (1)	7.84 ± .34
P7		8.82 ± 1.65 (2)	28.57 (1)				5 (2)	7.66 ± .37
P8		8.98 ± 1.40 (2)	28.97 (1)				1 (2)	7.64 ± .06
P9		8.84 ± 1.62 (2)	28.29 (1)				10 (2)	7.86 ± .08
P10		8.55 ± .78 (2)	--				12 (2)	9.23 ±1.87
P11		8.90 ± 1.53 (2)	29.05 (1)				19 (2)	7.75 ± .17
P12		8.91 ± 1.58 (2)	25.19 (1)				15 (2)	7.79 ± .01
P13		8.98 ± 1.66 (2)	25.60 (1)				23 (2)	7.78 ± .25
P14		8.18 ± .81 (2)	29.86 (1)				20 (2)	7.67 ± .10
OVERALL		8.57 ± 1.03(27)	28.78 ±1.66 (12)				16 (23)	7.99 ± .79

[1/] Data are shown for all variables (except FC) as mean ($\overline{X}$) ± 1 standard deviation(s). Numbers of data are shown in pare
means (G.M.) for FC data are shown. If there is only one value, this value is shown with (n) equal to 1.

[2/] December 15 values only.

[3/] January 28 values only.

2. - Continued[1/]

	Depth (m)	NO_3-N (mg/L) $\overline{X}$ ± s (n)	NO_2-N (mg/L) $\overline{X}$ ± s (n)	NH_3-N (mg/L) $\overline{X}$ ± s (n)	O-PO_4-P (mg/L) $\overline{X}$ ± s (n)	T-PO_4-P (mg/L) $\overline{X}$ ± s (n)	pH (units) $\overline{X}$ ± s (n)	Turb $\overline{X}$ ±
		<.2 (1)	<.2 (1)	13 (1)	4.0 (1)	5.9 (1)	7.0 (1)	51
...ZONE								
	0	.36 ± .03 (8)	<.01 (8)	.09 ± .03 (8)	.08 ± .01 (8)	.12 ± .01 (8)	7.6 ± .06 (4)	3.8 ±
	5	.39 ± .02 (2)	<.01 (2)	.06 ± .03 (2)	.08 ± .01 (2)	.12 ± .01 (2)	7.6 (1)	1.5 ±
	10	.39 ± .02 (2)	<.01 (2)	.02 ± .00 (2)	.08 ± .01 (2)	.10 ± .00 (2)	7.7 (1)	3.0 ±
	0	.38 ± .03 (2)	<.01 (2)	.05 ± .03 (2)	.08 ± .00 (2)	.10 ± .00 (2)	7.7 (1)	3.0 ±
	5	.38 ± .01 (2)	<.01 (2)	.02 ± .01 (2)	.08 ± .01 (2)	.10 ± .01 (2)	7.5 (1)	6.0 ±
	10	.39 (1)	<.01 (2)	.02 (1)	.07 (1)	.10 (1)	7.6 (1)	3.5 ±
	0	.39 ± .01 (2)	<.01 (2)	.04 ± .01 (2)	.08 ± .01 (2)	.10 ± .00 (2)	7.7 (1)	1.5 ±
	5	.39 ± .01 (2)	<.01 (2)	.02 ± .01 (2)	.08 ± .01 (2)	.10 ± .00 (2)	7.7 (1)	2.5 ±
	10	.39 ± .04 (2)	<.01 (2)	.02 ± .01 (2)	.08 ± .01 (2)	.10 ± .01 (2)	7.7 (1)	2.0 ±
	0	.39 ± .02 (2)	<.01 (2)	.05 ± .00 (2)	.08 ± .00 (2)	.11 ± .01 (2)	7.7 (1)	2.0 ±
	5	.39 ± .02 (2)	<.01 (2)	.04 ± .01 (2)	.08 ± .00 (2)	.10 ± .01 (2)	7.7 (1)	2.5 ±
	10	.39 ± .02 (2)	<.01 (2)	.02 ± .01 (2)	.08 ± .01 (2)	.10 ± .00 (2)	7.7 (1)	2.5 ±
...LL		.38 ± .02 (30)	<.01 (30)	.05 ± .03 (29)	.08 ± .01 (29)	.10 ± .01 (29)	7.7 ± .1 (15)	3.0 ±
...MBIENT STATION SIN001								
	0	.38 ± .01 (2)	<.01 (2)	.05 ± .03 (2)	.08 ± .01 (2)	.10 ± .00 (2)	7.7 (1)	2.0 ±
	5	.39 ± .00 (2)	<.01 (2)	.03 ± .01 (2)	.08 ± .01 (2)	.10 ± .00 (2)	7.6 (1)	1.5 ±
	10	.40 ± .01 (2)	<.01 (2)	.02 ± .01 (2)	.08 ± .01 (2)	.10 ± .00 (2)	7.7 (1)	6.5 ±
...LL		.39 ± .01 (6)	<.01 (6)	.03 ± .02 (6)	.08 ± .01 (6)	.10 ± .00 (6)	7.7 ± .1 (3)	3.3 ±
...SHORE FIXED SURFACE STATIONS								
		.38 ± .00 (2)	<.01 (2)	.03 ± .01 (2)	.07 ± .01 (2)	.11 ± .01 (2)	7.7 (1)	3.0 ±
		.58 (1)	<.01 (2)	.02 (1)	.05 (1)	.07 (1)	8.2 (1)	2
		.38 ± .02 (2)	<.01 (2)	.03 ± .01 (2)	.07 ± .01 (2)	.10 ± .00 (2)	7.8 (1)	3.5 ±
		.40 ± .01 (2)	<.01 (2)	.04 ± .01 (2)	.08 ± .01 (2)	.10 ± .00 (2)	7.7 (1)	2.0 ±
		.38 ± .02 (2)	<.01 (2)	.03 ± .00 (2)	.08 ± .01 (2)	.10 ± .00 (2)	7.7 (1)	3.5 ±
		.38 ± .01 (2)	<.01 (2)	.04 ± .01 (2)	.08 ± .01 (2)	.10 ± .00 (2)	7.7 (1)	2.5 ±
		.38 ± .00 (2)	<.01 (2)	.03 ± .01 (2)	.08 ± .01 (2)	.10 ± .01 (2)	7.7 (1)	3.5 ±
		.36 ± .01 (2)	<.01 (2)	.09 ± .06 (2)	.10 ± .04 (2)	.13 ± .06 (2)	7.7 (1)	2.0 ±
		.38 ± .02 (2)	<.01 (2)	.04 ± .00 (2)	.08 ± .01 (2)	.09 ± .01 (2)	7.7 (1)	2.0 ±
		.39 (1)	<.01 (1)	.02 (1)	.06 (1)	.08 (1)	7.8 (1)	2
		.40 ± .01 (2)	<.01 (2)	.04 ± .00 (2)	.08 ± .01 (2)	.10 ± .01 (2)	7.7 (1)	2.5 ±
		.41 ± .02 (2)	<.01 (2)	.04 ± .01 (2)	.08 ± .01 (2)	.10 ± .01 (2)	7.7 (1)	2.0 ±
		.47 ± .08 (2)	<.01 (2)	.03 ± .01 (2)	.05 ± .01 (2)	.08 ± .01 (2)	7.7 (1)	3.5 ±
		.40 ± .01 (2)	<.01 (2)	.05 ± .01 (2)	.08 ± .01 (2)	.10 ± .00 (2)	7.7 (1)	3.0 ±
...LL		.40 ± .05 (26)	<.01 (26)	.04 ± .02 (26)	.07 ± .02 (26)	.10 ± .02 (26)	7.8 ± .1 (14)	2.7 ±

[1/] Data are shown for all variables (except FC) as mean ($\overline{X}$) ± 1 standard deviation (s). Numbers of data are shown in pa... means (G.M.) for FC data are shown. If there is only one value, this value is shown with (n) equal to 1.

[2/] December 15 values only.

[3/] January 28 values only.

Table 3. Summary of water quality data collected at Sinclair Inlet and within the mixing zone of Port Orchard STP during
conditions, March 25, 1981.[1/]

Stn. No.	Depth (m)	Temp. (°C) $\overline{X}$ ± s (n)	Salinity (in situ, o/oo) $\overline{X}$ ± s (n)	Sigma-t $\overline{X}$ ± s (n)	Secchi Depth (m) $\overline{X}$ ± s (n)	Dye (ug/L)	FC (org per 100 ml) G.M. (n)	D.O. (mg/L) $\overline{X}$ ± s (n)
STP							6.9×10^6	
MIXING ZONE								
A	0	10.92 ± .25 (4)	28.16 ± .04 (4)	21.49 ± .03 (4)	4.8 ± .3 (4)	--	1 (4)	10.58 ± .41
	5	10.52 (1)	28.29 (1)	21.68 (1)		.13 (1)	8 (1)	10.64
	10	10.62 (1)	28.66 (1)	21.94 (1)		.09 (1)	<1 (1)	8.29
B	0	11.15 (1)	27.97 (1)	21.33 (1)	4.5 (1)	4.59 (1)	<1 (1)	10.55
	5	10.58 (1)	28.34 (1)	21.70 (1)		.09 (1)	2 (1)	10.66
	10	10.10 (1)	28.59 (1)	21.97 (1)		.09 (1)	2 (1)	8.65
C	0	11.05 (1)	28.18 (1)	21.50 (1)	3.6 (1)	.60 (1)	2 (1)	10.55
	5	10.40 (1)	28.35 (1)	21.75 (1)		.09 (1)	3 (1)	10.78
	10	9.95 (1)	28.64 (1)	22.03 (1)		-- --	<1 (1)	8.56
D	0	10.72 (1)	28.14 (1)	21.52 (1)	4.5 (1)	2.04 (1)	<1 (1)	10.63
	5	10.30 (1)	28.32 (1)	21.74 (1)		.17 (1)	4 (1)	10.72
	10	9.92 (1)	28.60 (1)	22.00 (1)		--	2 (1)	10.46
OVERALL		10.60 ± .41(15)	28.21 ± .22 (15)	21.67 ± .23 (15)			2 (15)	10.19 ± .90(
DOE AMBIENT STATIONS								
SIN002	0	10.60 (1)	27.89 (1)	21.35 (1)			4 (1)	10.24
	5	10.20 (1)	28.58 (1)	21.95 (1)			2 (1)	8.86
SIN001	0	10.40 (1)	28.32 (1)	21.73 (1)	5.4 (1)		1 (1)	9.49
	5	10.07 (1)	28.54 (1)	21.94 (1)			2 (1)	10.42
	10	9.95 (1)	28.69 (1)	22.07 (1)			3 (1)	8.92
OVERALL		10.24 ± .26 (5)	28.40 ± .32 (5)	21.81 ± .28 (5)			2 (5)	9.59 ± .72
NEARSHORE FIXED SURFACE STATIONS								
P1		10.40 (1)	28.21 (1)				2 (1)	--
P2		--	--				--	9.48
P3		11.10 (1)	28.29 (1)				<1 (1)	--
P4		10.40 (1)	28.21 (1)				<4 (1)	10.74
P5		11.00 (1)	27.91 (1)				2 (1)	11.04
P6		11.20 (1)	28.01 (1)				1 (1)	10.50
P7	0	11.08 (1)	28.11 (1)				1 (1)	10.60
P8		10.85 (1)	28.30 (1)				<1 (1)	9.20
P9		11.30 (1)	26.90 (1)				9 (1)	10.70
P10		--	--				--	12.57
P11		10.40 (1)	27.49 (1)				7 (1)	11.13
P12		10.55 (1)	28.16 (1)				5 (1)	10.30
P13		10.60 (1)	28.28 (1)				<1 (1)	--
P14		10.95 (1)	28.15 (1)				<1 (1)	11.35
OVERALL		10.82 ± .33(12)	28.00 ± .41 (12)				2 (12)	10.69 ± .90(

[1/] Data are shown for all variables (except F.C.) as mean ($\overline{X}$) ± 1 standard deviation (s). Numbers of data are shown in pa
means (G.M.) for FC data are shown. If there is only one value, this value is shown with (n) equal to 1.

... 3. - Continued[1]

Station	Depth (m)	NO_3-N (mg/L) $\overline{X}$ ± s (n)	NO_2-N (mg/L) $\overline{X}$ ± s (n)	NH_3-N (mg/L) $\overline{X}$ ± s (n)	O-PO_4-P (mg/L) $\overline{X}$ ± s (n)	T-PO_4-P (mg/L) $\overline{X}$ ± s (n)	pH (units) $\overline{X}$ ± s (n)	Turb... $\overline{X}$ ±...
		<0.10	<.10	12	3.5			61
...NG ZONE								
	0	.26 ± .02 (4)	<.04 ± .00 (4)	.03 ± .03 (4)	.06 ± .01 (4)		7.9 ± 0.0 (4)	2.2 ±
	5	.26 (1)	<.01 (1)	<.01 (1)	.05 (1)		7.8 (1)	2
	10	.36 (1)	<.01 (1)	<.01 (1)	.06 (1)		7.7 (1)	3
	0	.28 (1)	<.01 (1)	.04 (1)	.06 (1)		7.9 (1)	2
	5	.28 (1)	<.01 (1)	.01 (1)	.06 (1)		7.9 (1)	4
	10	.35 (1)	<.01 (1)	.01 (1)	.07 (1)		7.8 (1)	4
	0	.28 (1)	<.01 (1)	.05 (1)	.06 (1)		7.9 (1)	5
	5	.27 (1)	<.01 (1)	<.01 (1)	.06 (1)		8.0 (1)	2
	10	.35 (1)	<.01 (1)	<.01 (1)	.06 (1)		7.8 (1)	1
	0	.28 (1)	<.01 (1)	.02 (1)	.06 (1)		7.9 (1)	1
	5	.27 (1)	<.01 (1)	.02 (1)	.06 (1)		7.8 (1)	3
	10	.33 (1)	<.01 (1)	<.01 (1)	.06 (1)		--	4
...RALL		.29 ± .04 (29)	<.01 (15)	.02 ± .02 (15)	.06 ± .01 (15)		7.9 ± .1 (14)	2.7 ±
... AMBIENT STATIONS								
...IN002	0	.28 (1)	<.01 (1)	.09 (1)	.06 (1)		7.9 (1)	3
	5	.34 (1)	<.01 (1)	.01 (1)	.07 (1)		7.8 (1)	5
SIN...01	0	.28 (1)	<.01 (1)	.01 (1)	.06 (1)		7.9 (1)	3
	5	.32 (1)	<.01 (1)	.04 (1)	.07 (1)		7.8 (1)	3
	10	.34 (1)	<.01 (1)	.01 (1)	.07 (1)		7.8 (1)	3
...ALL		.31 ± .03 (5)	<.01 (5)	.03 ± .03 (5)	.07 ± .01 (5)		7.8 ± .0 (5)	3.4 ±
...RSHORE FIXED SURFACE STATIONS								
		.24 (1)	<.01 (1)	.03 (1)	.06 (1)		7.8 (1)	2
		--	--	--	--		--	--
		.26 (1)	<.01 (1)	.02 (1)	.06 (1)		7.9 (1)	2
		.29 (1)	<.01 (1)	.05 (1)	.06 (1)		7.9 (1)	2
		.28 (1)	<.01 (1)	.02 (1)	.06 (1)		7.9 (1)	3
		.27 (1)	<.01 (1)	.01 (1)	.06 (1)		7.9 (1)	3
		.25 (1)	<.01 (1)	.01 (1)	.06 (1)		7.9 (1)	3
		.24 (1)	<.01 (1)	.02 (1)	.06 (1)		7.9 (1)	4
		.23 (1)	<.01 (1)	.05 (1)	.06 (1)		7.9 (1)	4
		--	--	--	--		--	--
		.26 (1)	<.01 (1)	.02 (1)	.06 (1)		7.9 (1)	1
		.25 (1)	<.01 (1)	.07 (1)	.06 (1)		7.9 (1)	2
		.27 (1)	<.01 (1)	.01 (1)	.06 (1)		7.9 (1)	4
		.23 (1)	<.01 (1)	.01 (1)	.06 (1)		7.9 (1)	4
...RALL		.26 ± .02 (12)	<.01 (12)	.03 ± .02 (12)	.06 ± .00 (12)		7.9 ± .0 (12)	2.8 ±

[1] Data are shown for all variables (except F.C.) as mean ($\overline{X}$) ± 1 standard deviation (s). Numbers of data are shown in... means (G.M.) for FC data are shown. If there is only one value, this value is shown with (n) equal to 1.

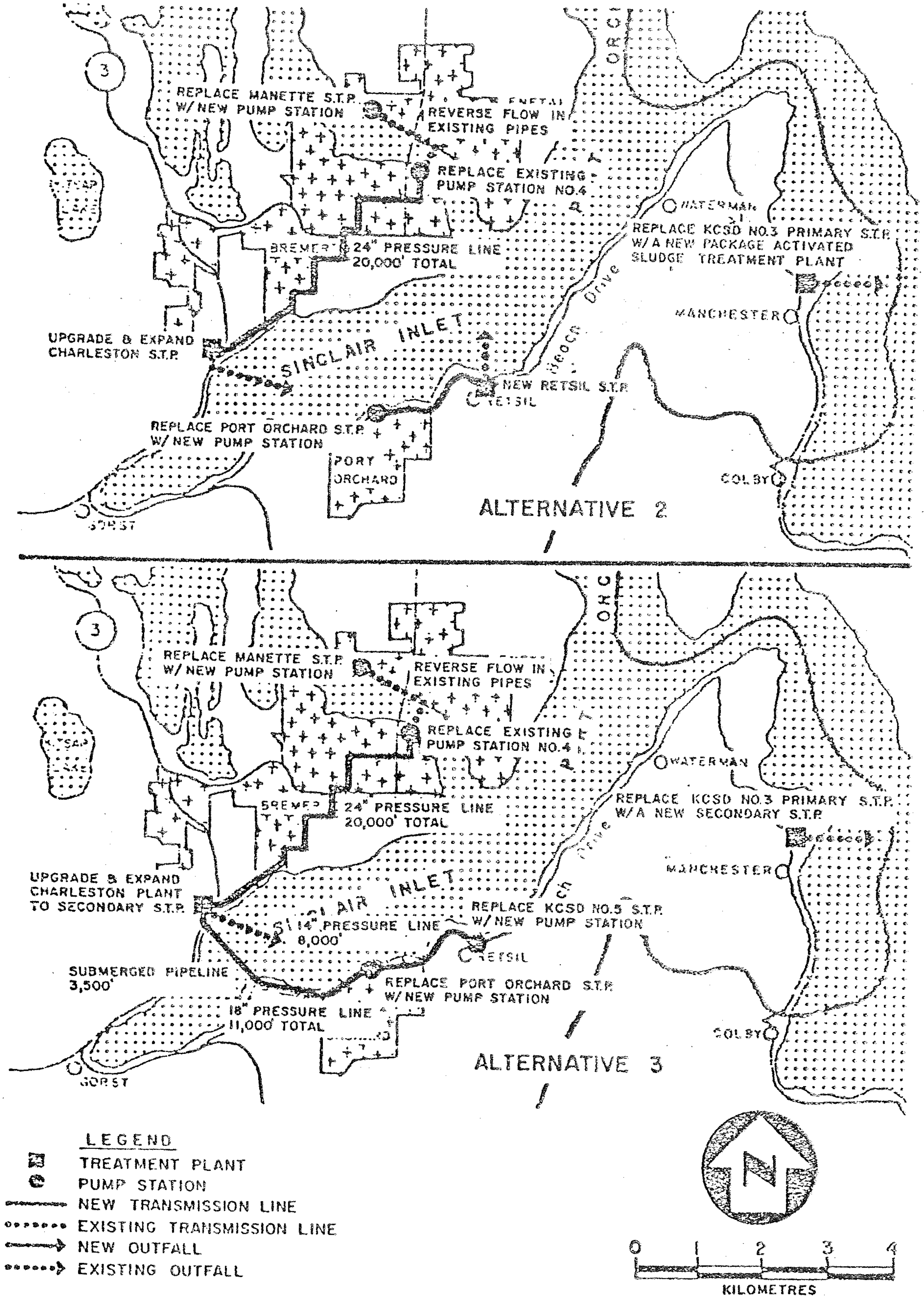
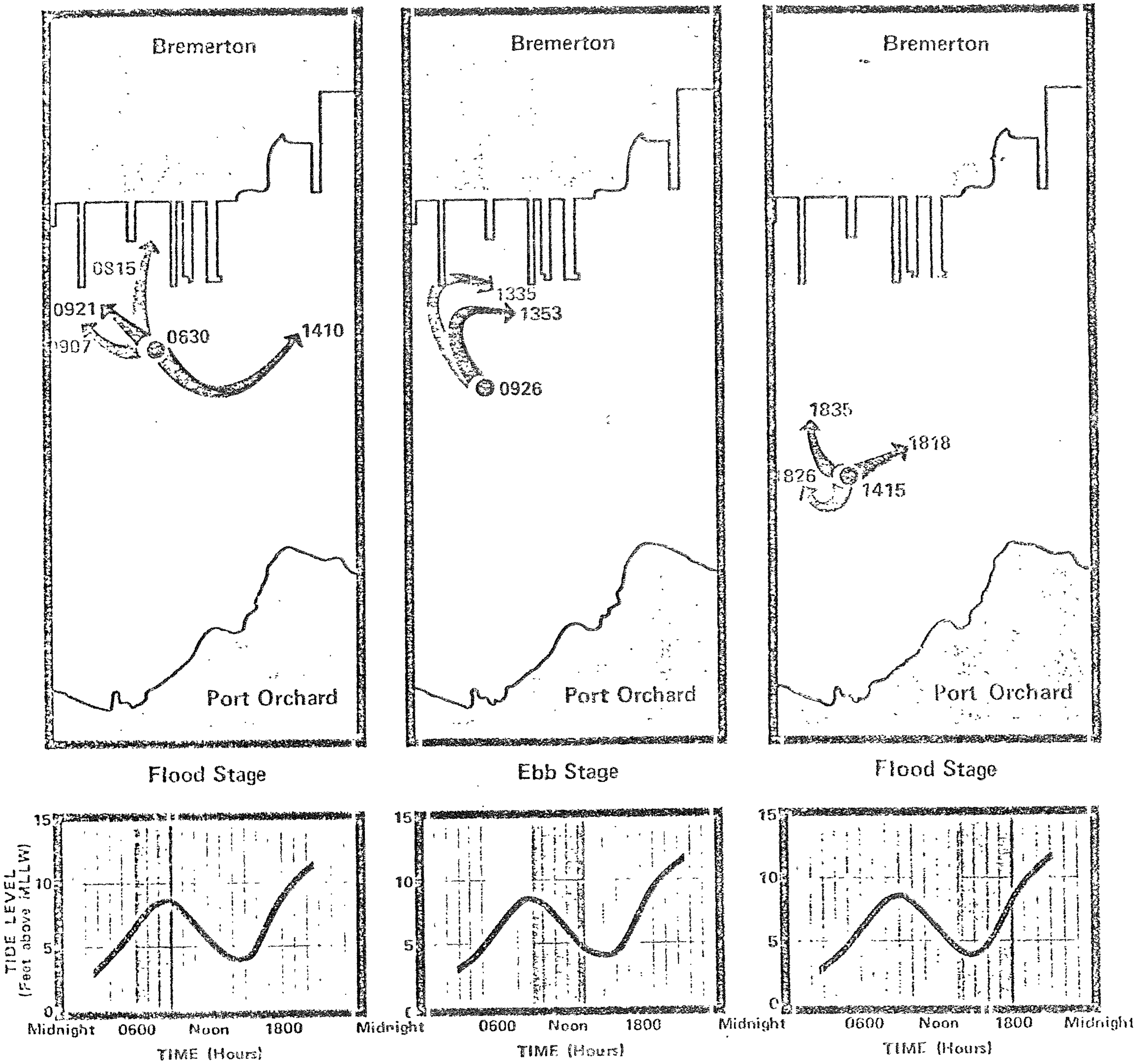

REPLACE MANETTE S.T.P. W/ NEW PUMP STATION
REVERSE FLOW IN EXISTING PIPES
REPLACE EXISTING PUMP STATION NO.4
WATERMAN
REPLACE KCSD NO.3 PRIMARY S.T.P. W/ A NEW PACKAGE ACTIVATED SLUDGE TREATMENT PLANT
24" PRESSURE LINE 20,000' TOTAL
MANCHESTER
UPGRADE & EXPAND CHARLESTON S.T.P.
SINCLAIR INLET
NEW RETSIL S.T.P.
REPLACE PORT ORCHARD S.T.P. W/ NEW PUMP STATION
PORT ORCHARD
COLBY
GORST
ALTERNATIVE 2
REPLACE MANETTE S.T.P. W/ NEW PUMP STATION
REVERSE FLOW IN EXISTING PIPES
REPLACE EXISTING PUMP STATION NO.4
WATERMAN
REPLACE KCSD NO.3 PRIMARY S.T.P. W/ A NEW SECONDARY S.T.P.
24" PRESSURE LINE 20,000' TOTAL
MANCHESTER
UPGRADE & EXPAND CHARLESTON PLANT TO SECONDARY S.T.P.
REPLACE KCSD NO.5 S.T.P. W/ NEW PUMP STATION
14" PRESSURE LINE 8,000'
SUBMERGED PIPELINE 3,500'
REPLACE PORT ORCHARD S.T.P. W/ NEW PUMP STATION
18" PRESSURE LINE 11,000' TOTAL
COLBY
GORST
ALTERNATIVE 3
LEGEND
TREATMENT PLANT
PUMP STATION
NEW TRANSMISSION LINE
EXISTING TRANSMISSION LINE
NEW OUTFALL
EXISTING OUTFALL
N
0 1 2 3 4
KILOMETRES

FIGURE 1.



29 July 1975

⊖	Starting Point
←	Surface Drogues (2-meter depth)
←	Mid-depth Drogues (5-meter depth)
←	Bottom Depth Drogues (8-meter depth)
0926	Time (Hours)

Figure ~~A-2~~ 2.
Sinclair Inlet
Drogue Study Data

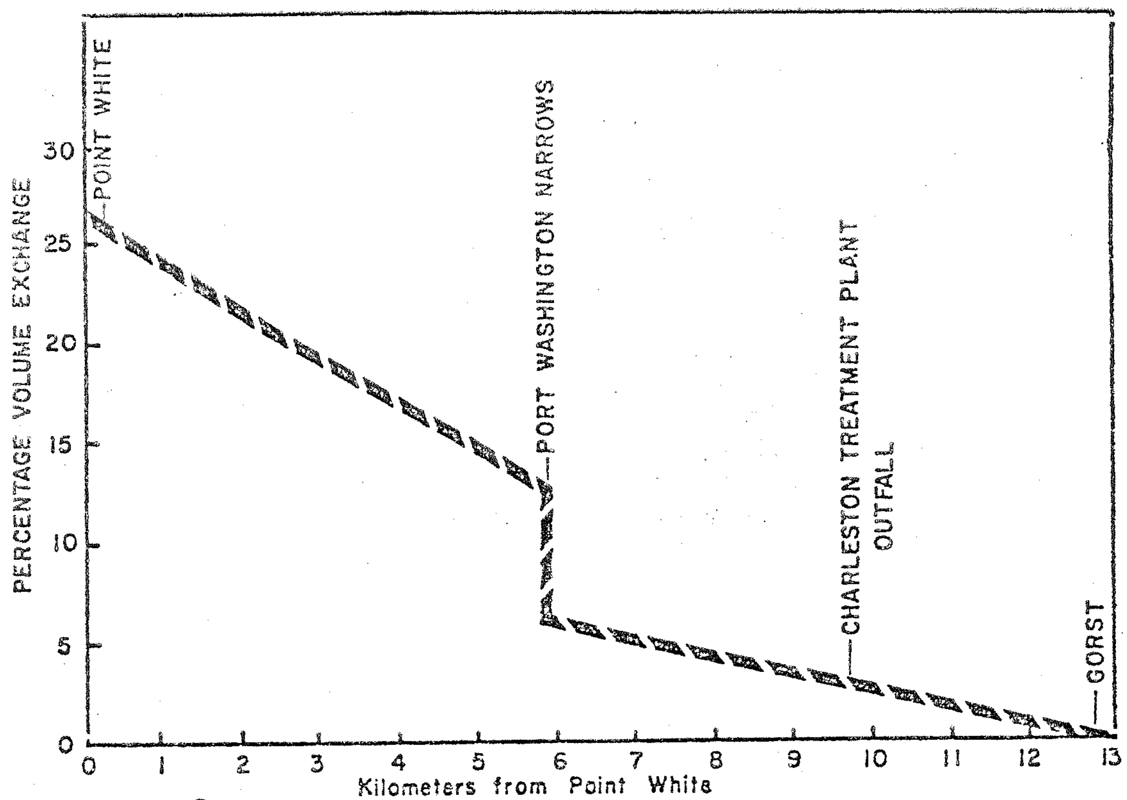
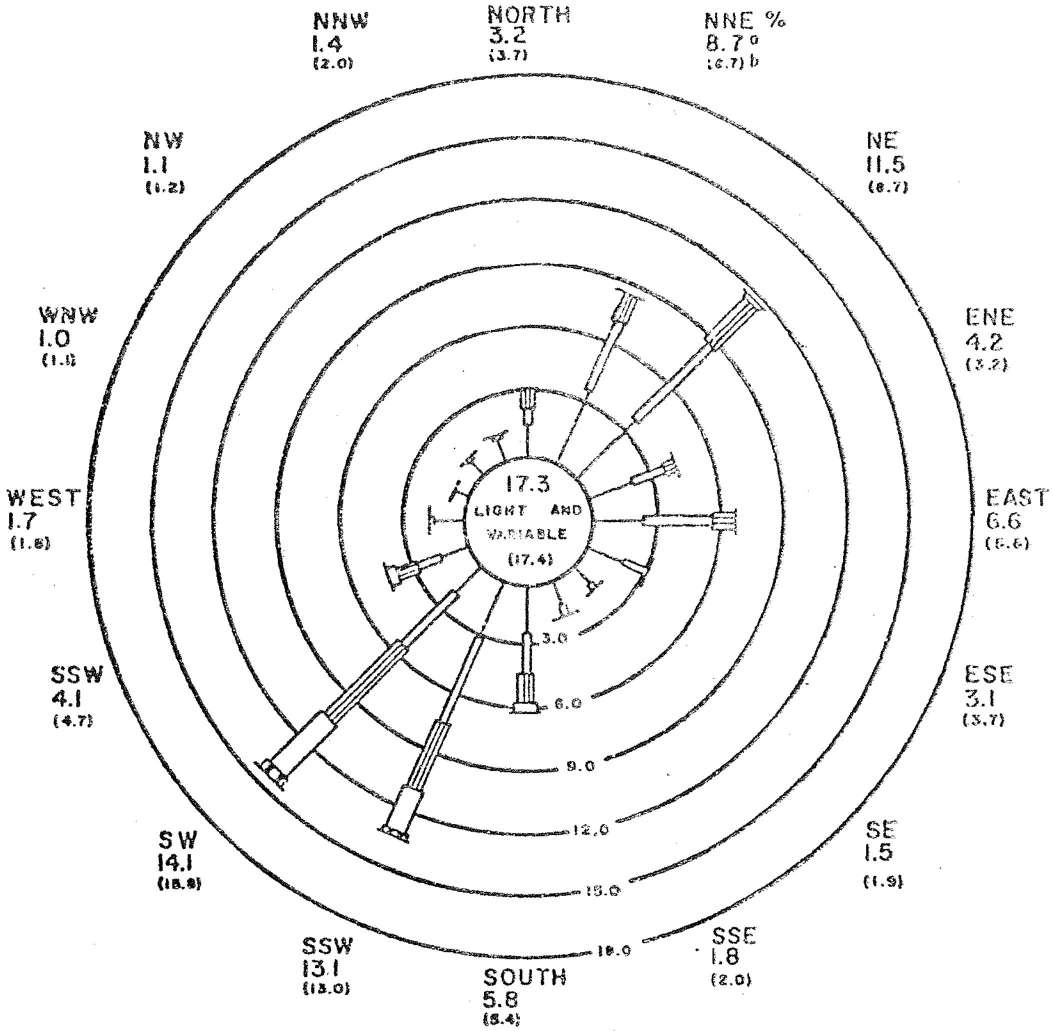


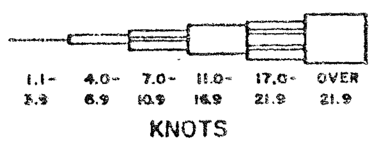
FIGURE ~~21~~ 3. TIDAL EXCHANGE IN SINCLAIR INLET / LOWER PORT ORCHARD BAY

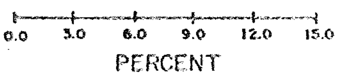


LOCATION – PUGET SOUND AIR POLLUTION CONTROL AGENCY, DEWEY JR. HIGH, PERRY AVE
AND HOLMAN ST., BREMERTON, WASHINGTON

DATES – [a]JUL-DEC, 1974. [b](JUL-APR, 1975) DIRECTIONAL FREQUENCY ONLY

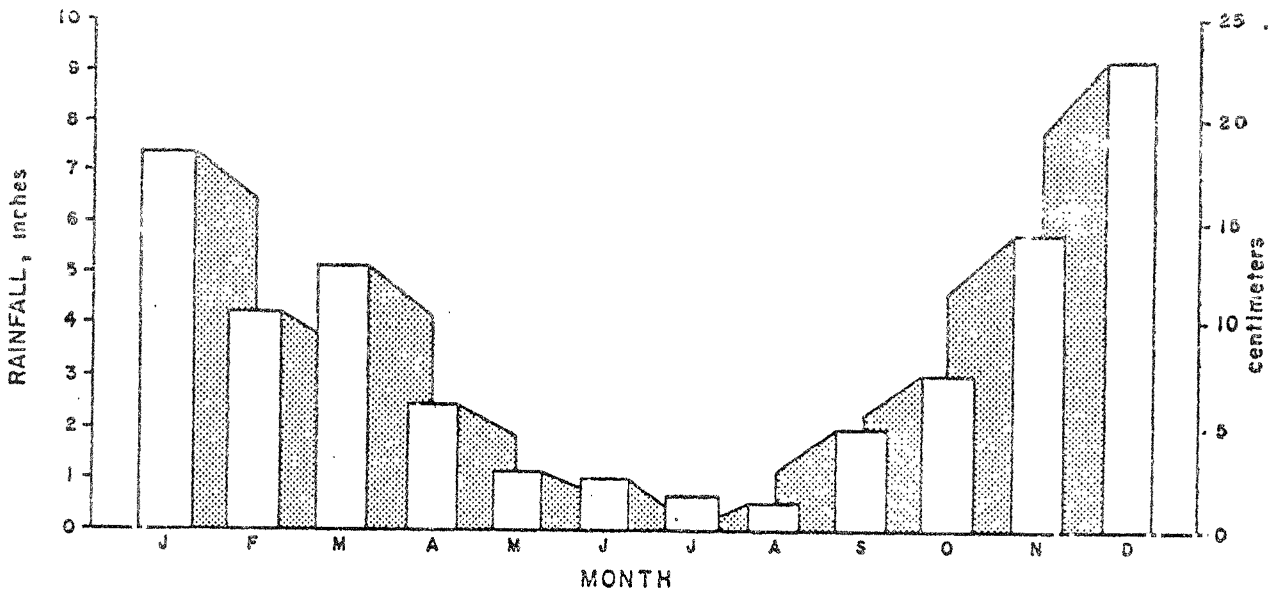
OBSERVATIONS – 3,976





Source: Reference 3.

Figure ~~8~~ 4. PERCENTAGE FREQUENCY OF OCCURRENCE OF HOURLY AVERAGE SURFACE WINDS.



~~SOURCE: REFERENCE 1~~

FIGURE ~~7~~ 5. : AVERAGE MONTHLY PRECIPITATION FOR THE TEN YEAR PERIOD 1965 - 1974, BREMERTON GAGING STATION

Winds

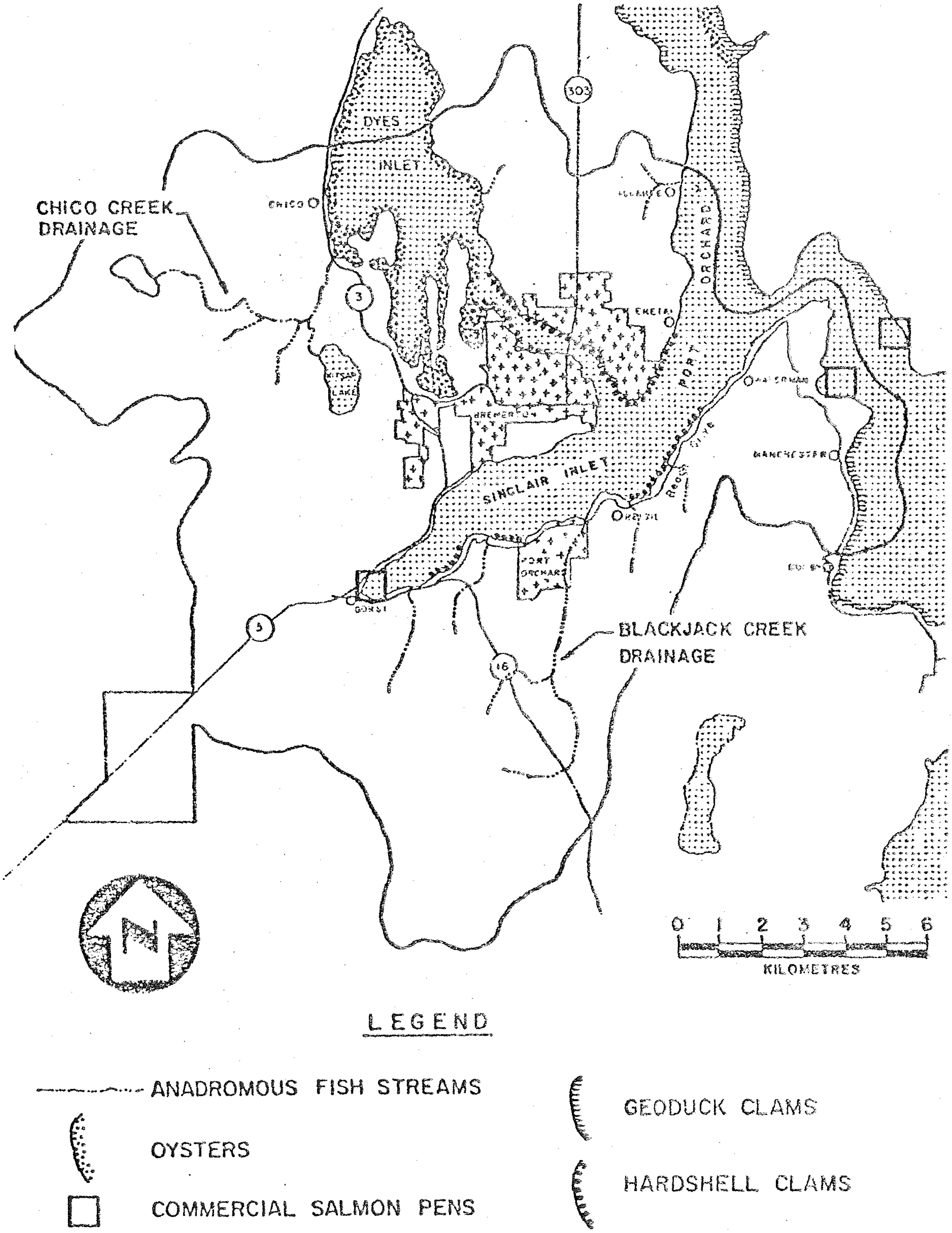


FIGURE ~~12~~ 6. AQUACULTURAL RESOURCES

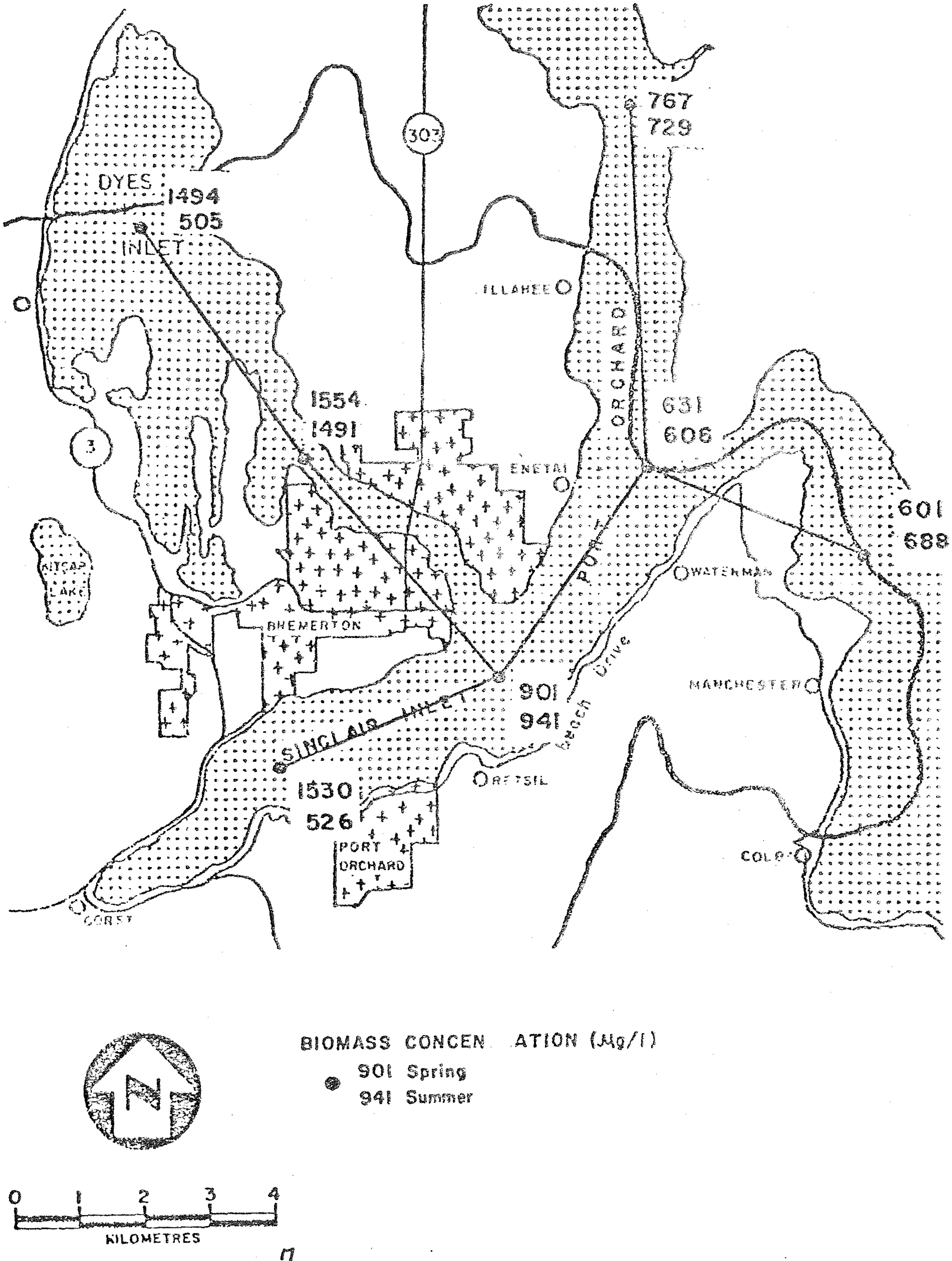
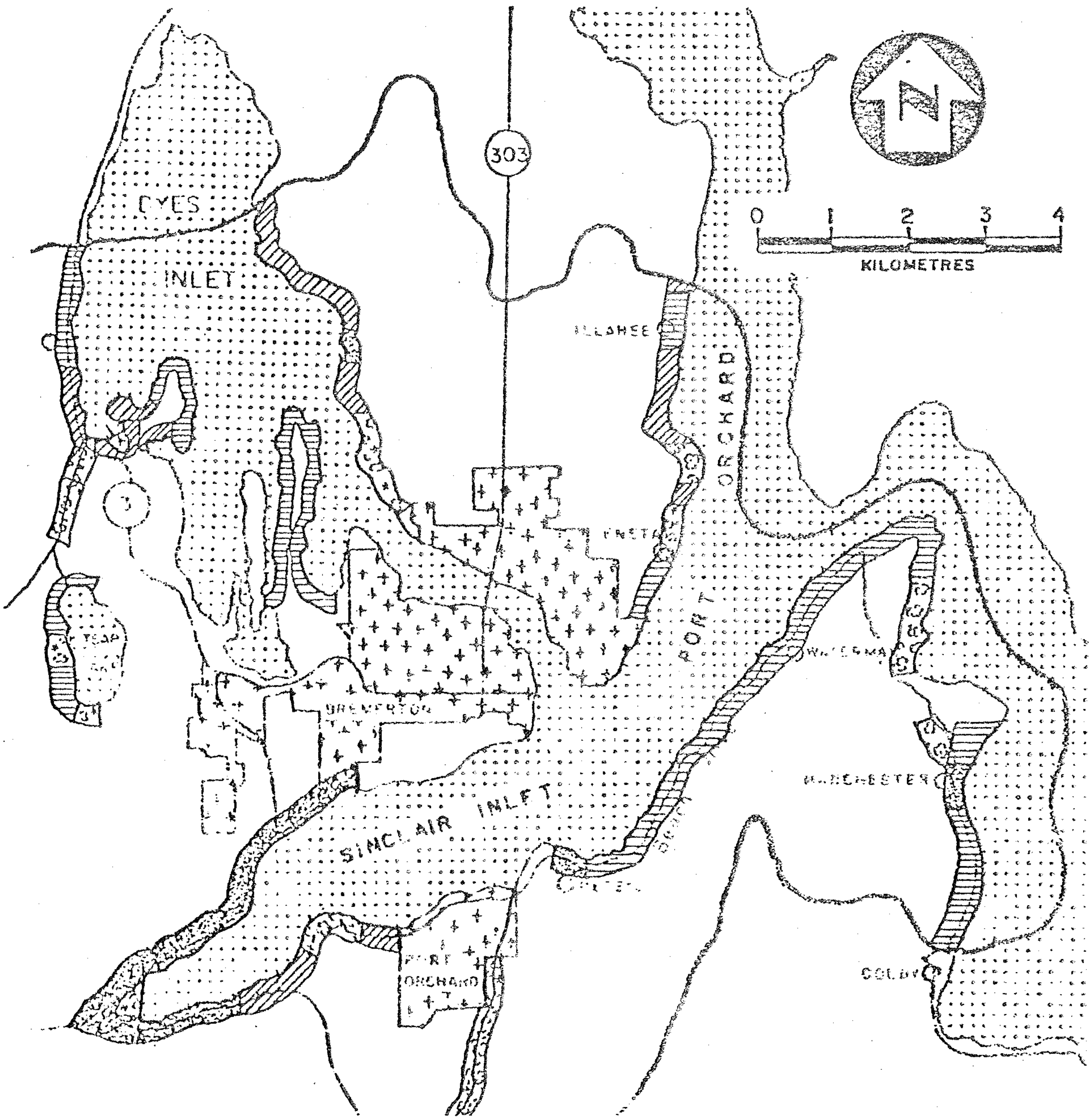


FIGURE ~~11~~ 7 COMPUTED ALGAL BIOMASS CONCENTRATIONS



LEGEND

URBAN

RURAL

SEMI-RURAL

CONSERVANCY

FIGURE ~~20.~~ 8. KITSAP COUNTY SHORELINE MANAGEMENT PROGRAM (JULY 1977)

Table ~~19.~~ 1. MAJOR MARINE FAUNA AND USAGES IN THE VICINITY OF PROPOSED WASTEWATER DISCHARGE SITES

Marine environment summary	Sinclair Inlet outfall sites	Manchester outfall site
Mussels	x	x
Barnacles	x	-
Cockles	x	-
Manila clam	-	x
Bentnose clam	x	-
Butter clam	-	x
Geoduck (subtidal)	x	x
Littleneck clam (subtidal)	x	x
Mixed shellfish	x	x
Herring spawning areas	-	x
Surf smelt spawning areas	-	x
Major waterfowl areas	x	x
Eelgrass beds	x	-
General fishing area (sport salmon)	x	x
Concentrated fishing area (sport salmon)	x	x
Commercial salmon fishing (gill net)	x	-
Nonsalmon sports fishing		
Cutthroat	x	-
Bottom fish	x	-
Commercial otter trawl		
Regularly fished	-	-
Historically fished	x	-
Closed to trawl	-	x
Commercial herring fishing	x	-
College of Fisheries research areas	x	-
State tidelands	a	-
Aquatic land use allocations		
Bedlands: aquaculture	-	x
Bedlands: commercial	x	-
Tidelands: Commercial	-	-
Marine terminals	x	x
Marine fuel stations	-	x
Shoreline zoned business/commercial	x	-
Presence of existing outfalls	x	x

Source: Reference 3
Note: "a" indicates nearby.

Table ~~6.~~ 2. MARINE HABITAT TYPES WITHIN THE STUDY AREA

Habitat	Description	Locations and Examples	Characteristic Associations
River-Creek Mouth	Estuarine zone where creek mouth meets marine waters. This zone extends to several meters below the low tide level and is subject to tidal and seasonal salinity changes.	Open systems-with direct creek outlet to marine waters-such as Chico Creek at Dyes Inlet.	Anadromous fish nursery areas-At depths greater than 1 ft below mean lower low water are productive eelgrass beds. Associated fish may include starry flounder, stickleback, eulachon, surf perch, sculpin and sole.
		Closed systems-creek mouth enclosed seasonally or permanently by sand spits or man-made obstructions, such as Annapolis Creek and other small creeks tributary to Sinclair Inlet.	Important waterfowl and shorebird habitat-sandy, silty bottom supports march grasses and invertebrates. During extreme climatic conditions, serves as important waterfowl shelter and feeding area.
Open-Mud Bays	Bays with limited circulation due to restricted inlet/outlet. The marine environment has no substantial fresh-water source and typically has an extensive intertidal zone, large mud flat areas and marsh grasses around the periphery.	Dyes Inlet system-including Oyster Bay, Ostrich Bay and Phinney Bay. Also includes lower end of Sinclair Inlet.	Subtidal eelgrass beds provide important feeding and spawning areas for Pacific herring, starry flounder, stickleback, eulachon, surf perch, sculpin and various flounder and sole species. Dungeness crabs, oysters and oyster drills are found in Chico Bay. Smelt spawning areas are along western Dyes Inlet shoreline.
Sand-Gravel-Cobble Beach	Typical shoreline type within Kitsap County. Shoreline is predominantly gravel and cobble gradating to semi-sandy substrate in the intertidal areas.	Major shoreline areas along Sinclair Inlet and Port Orchard.	March grass limited or absent, rockweed and sea lettuce typical in intertidal areas some eelgrass in subtidal areas. Typical invertebrate fauna consists of butter, littleneck and bent-nose clams, barnacles, shore and butter clams, tube worms, mussels and periwinkles.

Table ~~7.~~ 3. VERTICAL ZONES WITHIN THE MARINE ENVIRONMENT

Zone	Description	Locations and Examples	Characteristic Associations
Benthic Zone	Bottom-dwelling plant and animal community, includes infauna which may burrow several feet into substrate, epifauna which inhabit surface of substrate and demersal fish species.	Shallow portions of Dyes Inlet where bottom depth is less than 6 m [20 ft] deep.	Washington and manila clams, cockles, lean dog whelk and over 15 species of polychaetes dominated by lumberinerids, ampharetids, orbiniids and trichobranchids. For fish species, see Sinclair Inlet below.
		Southeastern end of Sinclair Inlet where bottom depth is less than 9 m [30 ft] deep.	Washington and other small clams: *Axinopsis serricatus* and *Psephidia lordi* are found in Sinclair Inlet, also lumberinerid and cirratulid polychaetes and cumaceans. Benthis fishes include: sping dogfish; bay goby; great, roughback and Pacific sculpins; speckled sanddab; starry flounder; and flathead, rock, slender, English, c-o and sand sole.
Water Column Zone	Mid-depth waters that may show gradations in temperature with moderate-to-good circulation. Some areas may be filled with kelp fronds forming a forest-lide environment.	Sinclair Inlet, Dyes Inlet, Port Orchard, Rich Passage and Puget Sound.	Important local fish species in the water column include stickleback, eulachon, bay pipefish, pricklebacks, shiner and pile perch, striped and white seaperch, sturgeon and pygmy poacher. Fishes favoring algal and other vegetative associations include northern clingfish, plainfin midshipman, blackbelly eelpout, whitespotted greenling and longspine combfish. Other pelagic fishes include Pacific herring, salmon, Pacific cod, Pacific hake, walleye pollock and Pacific tomcod.
Surface Zone	Surface waters which are strongly influenced by light, wind, temperature and human activities such as boating.	All marine waters within study area.	Important zone for phyroplankton and zooplankton production. Plankton population forms first step of food chain for benthic invertebrates and fishes. Fishes in surface zone are similar to water column zone with a preference for those tolerating warmer waters.

Table ~~5.~~ 4. QUARTERLY MONITORING OF COLIFORM BACTERIA LEVELS[a]

(Number /100 ml)

Sinclair Inlet Sampling Stations	6/12/72	8/29/72	12/27/72	3/7/73	6/19/73	9/5/73	12/17/73	3/5/74	6/24/74	9/17/74	1/7/75	3/18/75	6/10/75	9/12/75	12/19/75
1. Off Annapolis/Retsil STP[b]	40	43	460	93	>1100	<4	>1100	240	-	43	150	23	15	4	>1100
2. Off Port Orchard STP	150	11	>1100	4	460	9	>1100	460	15	4	460	75	<4	9	240
3. Off Port Orchard Yacht Club	40	<4	460	93	9	9	>1100	240	4	240	290	23	15	23	75
4. Gorst (off Rock Quarry)*	230	23	1100	1100	>1100	<4	>1100	1100	93	240	460	>1100	460	<4	150
5. Off Charleston STP	90	<4	210	93	<4	9	>1100	43	4	75	>1100	240	23	9	150
6. Off N.Y. Crane at Naval Shipyard *	40	23	>1100	93	15	1100	>1100	93	4	7	240	43	23	1100	43
7. Off Manette STP (Port Washington Narrows)	-	-	1100	1100	4	14	>1100	>1100	-	-	-	>1100	-	-	-

[a] Washington State DOE Classification of Sinclair Inlet: "A - special conditons" - total coliforms not to exceed median values of 100 associated with any fecal source, less than 20 percent should exceed 2400/100 ml.

[b] Sewage Treatment Plant (STP).

Source: Kitsap County Department of Public Health.

Table 5. Summary of DOE ambient monitoring data for Sinclair Inlet Station SIN001 from 1973 through 1978. Data are shown as means (numbers of samples). Water quality standards for each Sinclair Inlet water classification are shown.

Parameters	Surface (Z = 0 m)	Depth (Z - 10 m)	Water Quality Standards A (Charleston)	AA (Retsil)
Fecal Coliform (median; fc/100 ml)	2 (22)	4 (15)	14 (10% <43)	Same
Dissolved Oxygen (mg/l)	10.32 (22)	8.06 (20)	>6.0 (degradation not to exceed 0.2)	Same
Temperature (°C)	12.86 (22)	11.93 (22)	<16°C due to human causes	<13°C due to human causes
pH (units)	8.00 (22)	7.84 (22)	7.0-8.5 (man-causes not to exceed 0.5)	7.0-8.5 (man-causes not to exceed 0.2)
Salinity (%)	28.19 (19)	28.69 (19)	--	--
NO_3-N (mg/l)	0.13 (21)	0.21 (21)	--	--
NO_2-N (mg/l)	0.00 (21)	0.00 (21)	--	--
NH_3-N (mg/l)	0.04 (21)	0.06 (21)	--	--
O-PO_4-P (mg/l)	0.03 (21)	0.04 (21)	--	--
T-PO_4-P (mg/l)	0.08 (21)	0.07 (21)	--	--

"<" = "less than"
">" = "greater than"

Table 6. Summary of data from Class II and receiving water studies at the Charleston and Retsil years. All samples taken from chlorinated effluent.

	Max. Flow MGD	BOD_5 mg/l (lbs/day)	TSS mg/l (lbs/day)	F. Coli. Col/100 ml	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	O-PO_4 mg/
Charleston								
May 1974	--	--	76	<10	0.65	0.15	10.4	2.2
Sept. 1977	2.24	140 (2,618)	62 (1,159)	7,000*	--	--	--	--
Dec. 1977	1.58	71 (936)	46 (606)	210	--	--	--	--
Nov. 1978	2.6	116 (2,515)	48 (1,051)	<10	<0.50	<0.50	21.0	4.6
NPDES Limit	5.0**	165 (4,800)	140 (4,100)	700**	--	--	--	--
Retsil								
Oct. 1978	0.45	165 (480)	60 (175)	600	<0.02	<0.02	26.0	8.0
NPDES Limit	--	165 (650)	100 (400)	700	--	--	--	--

"<" = "less than"
*Estimate
**Monthly average

Table 7. Summary of performance data from three STP's discharging into Sinclair Inlet.

Table 20. BREMERTON PLANT NO. 2 (CHARLESTON) EFFLUENT CHARACTERISTICS[a]

	Maximum Average Month	Minimum Average Month	6-Month Average
BOD5 (mg/l)	185	85	114
Suspended Solids (mg/l)	85	51	65
Fecal Coliform[b] (per 100 ml)	--	--	10
pH	7.9	7.0	7.5
Settleable Solids (mg/l)	2.8	Trace	0.2
Dissolved Oxygen (mg/l)	7.8	3.8	5.5
Nitrogen			
Total N (mg/l)[b]	--	--	18.4
NH_3 (N, mg/l)[b]	--	--	9.3
NO_3 (N, mg/l)[b]	--	--	0.51
Phosphate (P, mg/l)[b]	--	--	3.1

a Based on January 1975 to June 1975 operating data.
b Based on Department of Ecology sewage treatment plant efficiency study 18 March 1975.

Table 25. PORT ORCHARD EFFLUENT CHARACTERISTICS[a]

	Maximum Average Month	Minimum Average Month	6-Month Average
BOD5 (mg/l)[b]	185	91	154
Suspended Solids (mg/l)[b]	150	42	81
Fecal Coliform[c]	--	--	--
pH	7	6.9	7
Settleable Solids (mg/l)	2.0	Trace	0.5
Dissolved Oxygen (mg/l)[c]	--	--	--

a Based on January 1975 to June 1975 operating data.
b Based on February 1975 to August 1975 NPDES Permit Discharge records.
c No data available.

One half-time operator (grade IV) handles the operation and maintenance

Table 35. KCSD NO. 5 (RETSIL) EFFLUENT CHARACTERISTICS[a]

	Maximum Average Month	Minimum Average Month	7-Month Average
BOD5 (mg/l)	162	55	96
Suspended Solids (mg/l)	187	37	82
Fecal Coliform[b]	--	--	--
pH	7.5	6.5	7.2
Settleable Solids (mg/l)	2.6	0.1	0.8
Dissolved Oxygen (mg/l)	10.5	3.6	7.9

Table 8. Estimated diluted waste concentrations from secondary and primary discharge at Char

Concentration	Estimated Wastewater Concentration: Secondary Effluent[1] Undil.	10:1	100:1	Primary Effluent Undil.	10:1	100:1	Standar A
Fecal Coliform fc/100 ml	200	23	5	700[2]	73	10	14
BOD_5 (mg/l)	30	3	0.3	61[3]	6.1	0.6	--
TSS (mg/l)	30	3	0.3	47[3]	4.7	0.5	--
D.O. (mg/l)	3	8.7	9.2	--	--	--	6.00
Chlorine (mg/l)	0.1-0.5	0.01-0.05	0.00-0.005	2.4[4]	0.24	0.02	--
NH_3-N (mg/l)	20-25	2.05-2.55	0.25-0.30	--	--	--	--
pH (units)	6-9	7.9-8.2	7.9	--	--	--	7-8.5

[1] Calculated by EPA (1978) by application of the continuity equation.

[2] Current NPDES requirement for Charleston STP (Table 6).

[3] Estimated from designed influent levels (John Stetson, DOE).

[4] Average of four values shown on Table 6.

Table ~~37.~~ 9. ENVIRONMENTAL SUMMARY OF ADVERSE IMPACTS OF PROJECT ALTERNATIVES FOR THE SINCLAIR INLET SEWERAGE FACILITIES PLAN

Impacts	No Action 1	Charleston Regional/ Retsil Regional Manchester 2	Charleston Regional Manchester 3	Local Treatment Plants 4	Charleston Regional Manchester Regional 5
Soil stability and erosion hazards	Minor impact[a]	Minor impact	Moderate impact	Moderate impact	Moderate impact
Potential geological hazards	Minor impact	Minor impact	Minor impact	Moderate impact	Minor impact
Impact on air quality	No impact	Minor impact	Minor impact	Minor impact	Minor impact
Odor and noise generation potential	Moderate impact	Minor impact	Minor impact	Minor impact	Minor impact
Direct effects on stream water quality	Major impact	Minor impact	Minor impact	No impact	Minor impact
Degradation of groundwater quality	Major impact	Minor impact	Minor impact	Minor impact	Minor impact
Vegetation and terrestrial wildlife loss	No impact	Minor impact	Minor impact	Minor impact	Moderate impact
Marine water quality impact	Moderate impact	Minor impact	Minor impact	Minor impact	Minor impact
Marine biota (benthic organisms and fisheries)	Moderate impact	Moderate impact	Moderate impact	Moderate impact	Moderate impact
Stimulation of algal blooms	Major impact	Moderate impact	Moderate impact	Moderate impact	Moderate impact
Impact on land and property values	Minor impact	Minor impact	Minor impact	Major impact	Minor impact
Loss in property tax revenue	No impact	Minor impact	Minor impact	Major impact	Minor impact
Increase in municipal service costs	No impact	Moderate impact	Minor impact	Moderate impact	Moderate impact
Consumptive use of energy	Minor impact	Moderate impact	Moderate impact	Minor impact	Moderate impact
Impact on recreation facilities	Minor impact	No impact	No impact	Minor impact	No impact
Impact upon aesthetic qualities	Moderate impact	Minor impact	Minor impact	Moderate impact	Minor impact

[a]Degree of Impact: Major impact; Moderate impact; Minor impact; No impact